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WITH WHICH IS INCORPORATED THE "CHEMICAL GAZETTE."

19 FEB 1923

A Journal of Theoretical and Practical Chemistry and Physics,

IN THEIR APPLICATION TO

ENGINEERING AND MANUFACTURES.

EDITED BY

JAMES H. GARDINER, F.Inst.P., F.C.S.

275

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THE CHEMICAL NEWS.

VOLUME CXXV.

EDITED BY JAMES H. GARDINER, F. Inst. P., F.C.S.

No. 3248.—JULY 14, 1922.

THE CHEMICAL NEWS,

VOL. CXXV., No. 3248

SAFEGUARDING OF INDUSTRIES ACT.

Awards in Arbitrations Under Section 1 (5).

Judgment has been given by the Referee in Arbitrations relating to the following complaints under the above Sub-Section.

In accordance with the Award, "Acid Boric" is removed from the lists of articles chargeable with duty under Part 1. of the Act as from 29th June:—

Nature of Complaint.

1. That "Acid Boric" is improperly included in the lists of dutiable articles.
2. That Re-agent Bottles, Hydrometer Jars, Museum Jars, Specimen Jars, Surgical Jars, Cylindrical Measures (bell-shaped) and Conical Measures, are improperly included in the lists of dutiable articles.

Judgment.

1. That "Acid Boric" be removed from the lists.
2. Text of Award given below.

The Referee's Award.

Scientific Glassware.

In my opinion the question whether the descriptions complained of are properly included in the list of dutiable articles depends upon the meaning of the words used. I am satisfied that all the descriptions complained of are properly included in the list provided that these descriptions are used strictly and within the limits which are defined in this award. Re-agent bottles are properly in the list provided that by the expression "re-agent bottle" is meant a bottle which is reasonably fit for containing chemical re-agents. The legal obligation implied on the sale of such bottles is that the bottle shall be reasonably fit for containing any ordinary chemical re-agent, not fit for just a few but fit for any chemical re-agent except possibly some exceptional substance calling for special and exceptional qualities in its container. This obligation means that the botle must be made of hard suitable glass free from lead. By "free" I mean containing no more than such a trace as does not matter. The neck and stopper must be ground so as to make a perfectly air-tight joint.

If a bottle does not fulfil these requirements, it is not suitable for containing chemical re-agents, and is not scientific glassware. I gather that the distinctive shapes of re-agent bottles have been copied and that the description has been applied to inferior bottles, and that these practices have led to trouble with the Customs. That trouble is not for m eto deal with.

A hydrometer jar means a jar suitable for hydrometer tests. It is of distinctive type, straight sided, of circular or elliptical section from 6 inches to 10 inches high. The glass must be good and very clear. The jar must be a very good cylinder and must be capable of standing rapid changes of temperature.

Cylindrical Measures (Bell-Shape) and Conical Measures.

I think that these measures are on the border line, and that the only articles of these descriptions which can properly be considered as scientific glassware are measures which are in fact graduated with scientific accuracy. It is the correct graduation which, according to the evidence, makes them scientific glassware. I award that the descriptions complained of are properly included in the list if and when defined within the limits I have laid down. The complaint therefore fails.

(*Signed*) Cyril Atkinson.

12th June, 1922.

[From the *Board of Trade Journal*, June 29th, 1922, page 719.]

DEHYDROTHIOTOLUIDIN: ITS ISOMERS, HOMOLOGUES, ANALOGUES, AND DERIVATIVES.

By Martin Meyer, B.Sc., M.A.

New York City.

(Continued from Last Week).

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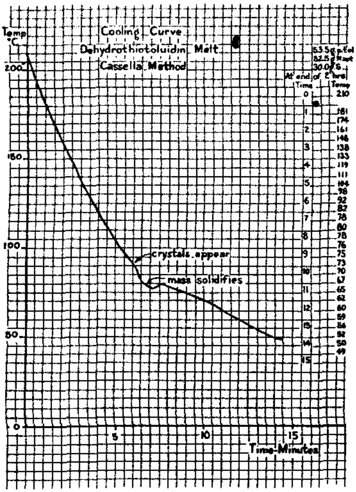
2. *The Kalle Method.*

It was observed that the relative amount of napthalene as required in the Casella Method could be varied greatly, without affecting the yield. (In order to determine whether there was compound formation between the napthalene and the other substances in the melt, a cooling curve was taken, which indicated that there was not, as may be seen from the diagram.) The napthalene was then omitted entirely, the fusion being carried out as directed in the Kalle patent, but extraction was still used for purification, and the yields and results were the same as those just described. It was therefore concluded that the claim that the use of napthalene increases the yield is unfounded, its only advantage being as a temperature regulator.

The method of purification by vacuum distillation was next tried in a preliminary way. For this purpose melts prepared by the Kalle method as well as samples of the crude material made similarly by the Du-Pont Co., were used. These melts distilled around 345° C. at a pressure of 35 mm. and yielded a product which on a single crystallisation from alcohol appeared in very pale yellow, odourless needles, which on further recrystallisation from ethyl alcohol were finally obtained at a constant melting point of 194.8° C. (cor.). This was undoubtedly pure and probably the purest sample of the compound which has been prepared up to this time. The procedure is a difficult one to carry out, the yeilds here were less than 20 per cent. of the weight of the starting material, and the distillation was accompanied by much foaming and decomposition, the greater part of the starting material remaining in the flask as coke at the end. As this was, however, finally concluded to be the only feasible method of purification, the complete details will be given later.



3. *Attempt to Develop a New Synthesis of Dehydrothiotoluidin.*

The work done on the compound up to this point led to the conclusion that in order to prepare a quantity of the substance sufficient for further investigation, and in a satisfactory state of purity, a new synthesis would be highly desirable. The criteria for this reaction as a laboratory problem are:

(*a*) Simplicity of mechanical operations.

(*b*) Large yield.

(*c*) Avoidance of the formation of primulin which prevents the satisfactory crystallisation of the compound without introducing large quantities of other by-products.

(*d*) Availability of starting materials.

From consideration of the general methods by which thiazoles have been prepared, the following proposed syntheses are obvious at once:

(*a*) Condensation of para-amino-meta-thiocresol with para-amino-benzoyl chloride.

(*b*) Fusion of para-amino-benz-para-toluidid with sulphur.

(c) Oxidation of thio-para-amino-benz-para-toluidid with potassium ferricyanide.

(d) Fusion of paranitro-benzal-para-toluidin with sulphur analagously to the patent method for preparing "Rosenkörper."[73] It was hoped that in this reaction, if it occurred at all, the hydrogen sulphide formed would reduce the nitro group to the amine, otherwise a final reduction would be necessary. This method was chosen as the easiest to perform because it is readily seen that the required Schiff's base should be easily obtained by condensation of paratoluidin and paranitrobenzaldehyde. This expectation was justified and the compound was prepared just before the publication of the article by Lowy and King[74] on the condensation products of paranitrobenzaldehyde in which it is described.

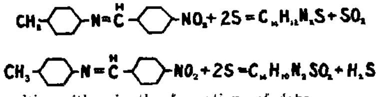
4. *Para Nitro Benzal Paratoluidin.*

Large quantities of chromyl chloride were prepared by the method of Law and Perkin,[75] and paranitrobenzaldehyde by that of V. V. Richter.[76]

Molecular quantities of the two substances, paratoluidin and paranitrobenzaldehyde, are dissolved separately in the least amounts of 95 per cent. ethyl alcohol and refluxed for one hour after mixing. The solution is evaporated to a small volume, allowed to crystallise, and the product filtered off and recrystallised from ethyl alcohol. Paranitrobenzal-paratoluidin appears in pale yellow needles melting at 123° C. (cor.). The yield is only about 50 per cent. of the theoretical in a pure state as it is very soluble in alcohol and the losses during crystallisation are large.

5. *Fusion of Paranitro-Benzal-Paratoluidide with Sulphur.*

It was expected that on fusion with sulphur this compound would behave in one of two ways, or perhaps, both, as follows:



resulting either in the formation of dehydrothiotoluidin or the corresponding nitro derivative.

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73. *D. R. P.*, 51, 172; Friedländer, Vol. 2.
74. Lowy and King, *J. A. C. S.*, 43, 627
75. Law and Perkin, *J. C. S.*, 91, 191 (1907).
76. V. V. Richter, *Berichte*, 19, 106 (1886).

Accordingly 16 g. of the Schiff base and 4 g. of powdered roll sulphur were mixed intimately and used on an oil bath in a flask equipped with a reflux condenser for 1½ hours at 200° C. Vigorous ebullition occurred almost at once, and sulphur dioxide was evolved rapidly. The mass became viscous at the end of three-quarters of an hour and was almost entirely solid at the end of one hour. Allowed to cool, broke the flask and pulverised the melt, which was black in colour and weighed 16 g. It was then extracted twice with concentrated hydrochloric acid in 100 cc. portions which were diluted with water, neutralised with sodium hydroxide and filtered. The acid solution changed from yellow to a milky purple at the neutral point. A small amount of purplish-brown material, the dry weight of which was less than 1 g. was obtained. The mass appeared to have charred to a large extent and the yield was too small to proceed further with. It was not dehydrothiotoluidin or the nitro compound, and resembled the product obtained later from nitrotoluene in every way.

It was thought that a lower temperature might improve the results, so the experiment was repeated, using xylenes as a diluent and temperature regulator.

A mixture of 12 g. of paranitro-benzal-paratoluidin, 55 cc. of xylenes, and 3 g. of sulphur, was refluxed for 5 hours, the mixture was then diluted with water and steam distilled, and the xylene recovered from the distillate. The residue in the flask consisted of a dark brown solid and a yellow substance, more of which is deposited in yellow needles from the water solution on cooling. Filtered and separated the yellow needles from the brown material which was present in large lumps. None of the starting material was obtained from this, although the brown mass did contain free sulphur. The products of the reaction were the brown, amorphous, insoluble material, and the yellow crystals, which are soluble in alcohol from which they crystallise in small crystals of indistinguishable shape, melting at 227-228° C. (cor.). The water solution of this compound is acid to litmus, qualitative analysis showed the presence of carbon, hydrogen, and nitrogen, and a sample gave the reduction test for the nitro group. It was not investigated further as it was evidently not the desired sulphur base.

6. *Fusion of Paranitrotoluene and Sulphur.*

At this point the thought suggested itself that paranitrotoluene should yield dehydro-

thiotoluidin or its nitro-body on fusion with sulphur by reactions similar to those already given.

(*a*) $2CH_3.C_6H_4NO_2 + 2S = C_{14}H_{12}N_2S + SO_2 + 2H_2O$

(*b*) $2CH_3.C_6H_4NO_2 + S = C_{14}H_{10}N_2SO_2 + 2H_2O$

A mixture of 30 g. of paranitrotoluene and 15 g. of sulphur was heated under a reflux condenser and for two hours sulphur dioxide was evolved vigorously. The melt, which on cooling weighed 29 g., was powdered and extracted three times with 100 cc. portion of concentrated hydrochloric acid which were then drowned in ten times their volume of water. On standing a dark brown flocculent precipitate settled out, and was filtered off and dried. It blackened up somewhat on standing, and weighed 7 g. when dry. The extract was pulverised and warmed with 100 cc. of ethyl alcohol, filtered, and the deep red solution was evaporated down and allowed to crystallise, yielding about a gram of light brown microcrystals that appeared to sublime or decompose around 220° C. Qualitative analysis showed the presence of carbon, hydrogen, nitrogen, and sulphur. Zinc dust in 50 per cent. ethyl alcohol appears to react with the substance as it gives a yellow solution with a pale green fluorescence, but the reaction mixture does not reduce ammoniacal silver nitrate and consequently the original substance is not a nitro compound.

Gatterman and Neuberg[77] prepared dehydrothiotoluidin from thio-paranitro-benztoluid by the Jacobson reaction. They describe the nitro compound as crystallising in yellow-red needles from glacial acetic acid, and none of the above mentioned substances resembles, even slightly, this or dehydrothiotoluidin.

The substance obtained in this reaction is a sulphur compound, probably identical with that obtained from para-nitro-benzalparatoluidid, has some tinctorial value, and does not correspond to any that have been prepared. As it can be made easily in moderately large quantities, it might be worth while to investigate the reactions further, but as for the preparation of dehydrothiotoluidin, these experiments failed, this was not done.

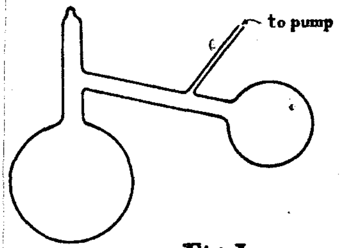

Fig. I

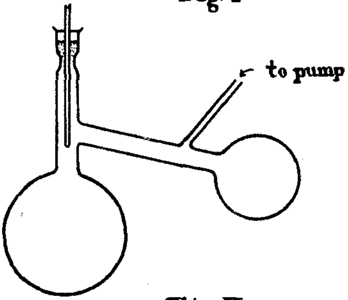

Fig. II

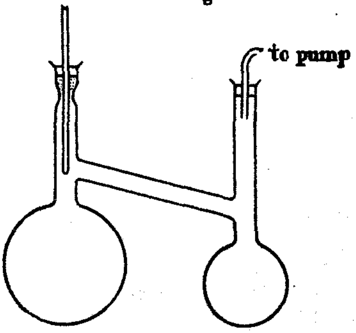

Fig. III

77. Gatterman and Neuberg, Berichte, 25, 1081 (1892).

'. Apparatus for the Vacuum Distillation of Dehydrothiotoluidin.

After attempting to prepare the compound in fairly large quantities by all of the nown methods, and unsuccessfully trying) develop a new one, it was finally conluded that the Kalle method offered the aly possibility, and purification must be ccomplished by vacuum distillation. Preminary work showed that the difficulties ere mainly low yields and the tendency of ie compound to swell up and run over aring the process of distillation making it npossible at first to obtain more than 10 g. ' the compound by this method in a single peration on a laboratory scale.

The apparatus first tried was the ordinary icuum distillation set up. At the lowest essures obtainable with a good water imp (20-30 mm.), dehydrothiotoluidin disls around 350° C., and it was found impssible to maintai na good vacuum at this mperature, using cork stoppers with the lditional difficulty of more rapid decomsition as the pressure rose, while further, narrow tube clogs up almost at once. ie first step was to modify the apparatus shown in the diagram (Fig. 1), the flasks ing 250 cc. Pyrex ones sealed together, id then the whole aparatus was sealed up ter the insertion of the mixed bases. The ating was done over a free flame. This d the disadvantage of ordinarily only beg capable of one run of 50 g. of mixture (if ore is used it will run over, because of the aming and decomposition), as it requires o great a degree of manipulative skill to t off the different parts at the end of the eration and then to seal them together ain, it being less trouble to make a new paratus, and in addition the closed argement did not give sufficient control of e run.

The next improvement (Fig. 2) was to aw out the neck of the distillation flask, ck the upper part with asbestos, and then se with a rubber stopper, through which thermometer can be inserted, which is otected from the heat by the asbestos. is was a decided advance, as two or three ccessive small amounts (50 g.) of mixed ses can be placed in the main flask and stilled before it is necessary to break the paratus to remove the yield, which disvantage still remains.

The final and best type of apparatus is own in Fig. 3. The distillation flask is a 0 cc. Pyrex one connected to a 250 cc. ceiver by a 6-inch length of Pyrex tubing of the same bore as the neck of the smaller flask. The set-up is evacuater through the neck of the receiver, and it is strongly recommended to place a U-tube of cotton wool between the safety bottle and the water pump during distillation, as otherwise, in spite of the best of cooling, the vapours will be carried along and clog up the water pump during distillation, and while this is being remedied there will be much loss of yield due to charring. Cooling is accomplished by immersing the receiver in a water-bath.

In this apparatus 100 g. (not more!) of the mixed base can be distilled at one run, yielding after crystallisation of the distillate once from 96 per cent. alcohol 22-25 g. of pure dehydrothiotoluidin. To avoid overheating, the distillation flask was heated in a sodium nitrate bath, but this was discarded as it was too difficult to control the foaming which inevitably accompanies the operation. If the distillation is done rapidly with a large free flame which also heats the delivery tube, this can be readily done by removing the flame and increasing the pressure judiciously from the stop-cock of the safety bottle when the melt appears to be about to run over, and when it has subsided distillation can be continued.

The advantages of this apparatus are as follows:

(1) The pure dehydrothiotoluidin can be easily removed by running hot alcohol through the delivery tube into the receiver by means of a rubber tube inserted into the neck of the distillation flask, which loosens it up, and it can then be broken up by shaking, and careful manipulation of a glass rod, and taken out.

(2) The apparatus can then be readily cleaned by soaking in hot concentrated sulphuric acid and so can be used repeatedly.

(3) The product obtained is pure and in good quantity, and the decomposition which accompanies the distillation can be controlled as all parts of the apparatus are accessible at all times.

(To be Continued.)

ISOTOPES OF TIN.

By F. H. Loring.

Dr. F. W. Aston announces in a recent issue of *Nature* (June 24th, 1922) that he has succeeded in determining what appear

to be *all* the isotopes of tin, by increasing the sensitiveness of the photographic plate used, there being no fewer than *eight* of these masses, viz.:—116, 117, 118, 119, 120, 121, 122, 124. Using two of the xenon lines for comparison, the tin isotope (120) contained in the compound $SnCH_3$ (=135) does not fall exactly midway between the xenon lines 134 and 136, thus indicating that this isotope is apparently a departure from a whole number. Aston states that all the tin values deviate perceptibly from integers by about a quarter of unity; so that taking the highest-mass isotope of the series, its mass might be *about* 123.75—to give an illustrative figure.

This appreciable departure from the integer value exists for *all* the other tin isotopes since their step-wise spacing is by *accurate* whole-number units measuring from the test value above. We are here reminded of Prof. Soddy's statement (*Chem. Soc. Proc.*, 1911, 99, p. 72), namely:—"The question naturally arises whether some of the common elements may not, in reality, be mixtures of chemically non-separable elements in constant proportions, differing step-wise by whole units in atomic weight. This would certainly account for the lack of regular relationships between the numerical values of the atomic weights." It will be seen how accurately this statement fits the present case of the tin isotopes.

The present writer was one of the first, if not *the* first, to develop along isotopic lines the strictly whole-number idea for the atomic weights and, with the exception of the tin isotopes, practically all the values thus far recorded have turned out to be whole numbers without appreciable decimal fractions, and in a number of cases the values given from time to time in these columns have been afterwards found to exist by the improved positive-ray methods. My values for tin were, however, 116 and 121 only. A few illustrative examples may be of interest. The values found by Dempster (see Aston's book, "Isotopes," 1922) for magnesium are 24, 25 and 26, while my previously stated values were 24 and 26.

My later prediction in the case of potassium was isotopes 39 and 41, which are exactly those found by Aston. Mercury is of interest in this connection, for the values were found to be (197-200), 202, 204; my values standing about symmetrically intermediate, thus . . . 199 . . . 203 . . . My values for zinc (64 and 68) compared with Dempster's later values (see Aston's book, p. 148), 64, 66, 68, 70, would seem to suggest that 66 and 70 are hydrides (ZnH_2); but there are some cases in which hydrides are ruled out, so that one is not justified in arriving at any conclusion in this respect; and, of course, it would be unscientific to attach to hypothetical values any importance, though I must point out that my conductivity relations were remarkable chance coincidences if they do not approximate to some truth. My chlorine values 35 and 40 are *not quite in agreement*, as the actual isotopes turned out to be 35 and 37. My articles in this journal for the past eight years show many close and exact predictions, but there were some failures. Of course, the credit undoubtedly belongs to the experimentalists; but it is not so easy as some might imagine to speculate and get close to the truth. It sometimes happens that the experimentalist is a poor speculator, and conversely the speculators are sometimes poor experimentalists; only in my case I have done a considerable amount of experimental work, but it does not happen to be in pure science. To experiment in pure science is *luxury work*, and few can afford to do this. Successful experimentation in this field is nevertheless exceedingly difficult, and an enormous amount of labour with patience is required, to say nothing of the highly-technical knowledge needed as a necessary equipment.

Returning to the question of the tin isotopes, the departures from integers raise important issues. Are these departures due to some peculiarity of the atoms or molecules in connection with Aston's deflection method? Or, do these departures involve *real* fractional masses of appreciable magnitude? Cæsium has apparently only one value, 133, yet the atomic weight obtained by the chemical method of analysis is 132.81. Perhaps this value will turn out to be 132.75 (say) to harmonise with the tin values. On the other hand, an additional lower-mass atom may be revealed by the use of more sensitive plates, in which case 133 may be a whole number without an appreciable decimal fraction. We may expect to hear of more isotopes being discovered now that an improvement in the photographic plate, as applied to this work, has been made.

It is of passing interest to note that the lead isotopes, including those of radio-active

origin, would probably be about equal in number to those of tin. Has there been some disintegration process that is now completely finished and which has left as its only heritage seven tin isotopes? If this speculation should prove true, perhaps nearly all the isotopes are really due to a backward process, if I may so describe it. That is to say, if the atoms produced by such a process could be eliminated from the complete list, there would be no isotopes in *the duplicate or multiple sense of the term.* Whatever may be said, the subject is full of interest experimentally and speculatively, for we live in an age of great activity in both fields, and no doubt there are many surprises in store.

THE SOLUBILITY OF POTASSIUM FERROCYANIDE.

By Reece H. Vallance, M.Sc., A.I.C.

A paper has recently been published by Fabris [Gazzetta, 1921, LI. (2), 374] on the solubility of potassium ferrocyanide between 0° and 100° C. The solubility of this salt, at temperatures up to 30° C. has engaged the attention of the writer for some considerable time, in view of the fact that results obtained by previous workers do not harmonise. For example, at 20° C., figures varying from 25 to 40 grams of $K_4 Fe(CN)_6$ in 100 grams of water have been given [Seidell, "Solubilities," Crosby Lockwood, 1920], and even the most recently obtained results are not concordant, as the following table shows:—

Temperature, °C.	Grams $K_4 Fe(CN)_6$ in 100 grams saturated solution.	Authority.
25	24.24	Wagner, Zeitsch. physikal chem., 1910, 71, 428.
25	25.53	Grube, 1914, vide Seidell's "Solubilities," 1920.
25	19.87	Harkins and Pearce, J. Amer. Chem. Soc., 1916, 38, 2714.
20	21.80	Briggs, Trans. Chem. Soc., 1911, 99, 1019.

This disagreement in results seems to have been largely due to errors in the method of estimating the amount of salt in the solution. The writer believes that he has been successful in overcoming this difficulty by using a new method of estimation, details of which will be published in due course. A series of determinations has been made at temperatures between 7° and 25° C., as shown in the accompanying table:—

Temperature. °C.	Solubility—grams $K_4 Fe(CN)_6$ in 100 grams saturated solution. Vallance.	Fabris.
10.4	17.541	17.95 (10°)
13.8	19.067	
16.9	20.862	
20.4	21.953	
23.1	23.074	23.36 (23°)
25.0	23.971	

Evidence has been obtained of a transition point in the neighbourhood of 18° C., but this has yet to be confirmed.

It had not been the intention of the writer to publish these results yet, but the communication by Fabris rendered this desirable.

Municipal Technical School,
Birmingham.

ABIETIC ACID AND METAL ABIETATES.

The preparation of abietic acid from rosin is described in the above paper by L. L. Steele (*Jour. Amer. Chem. Soc.*, 1922, p. 1333). The sample, in small lumps, is boiled under reflux with 98 per cent. acetic acid for 2 hours, and the solution filtered while hot through a pleated filter. The acid crystallised out overnight on standing in the cool. The crude acid is best recrystallised from glacial acetic acid. The acid, recrystallised three times from alcohol gave, in alcoholic solution (10 gm. per 100 cc.s) $[\alpha]^{20}_{D}$ −80.0°, and had an iodine valued at 0° C., 152.95 (mean); at 22-23° C., 168.55 (mean), at 25°-26° C. 169.8 (mean), the theoretical value being 167.9. The acid value of the acid (M.P. 161° to 165° C.) was 186.0 that for a mono-basic acid $C_{20}H_{30}O_2$ being 185.6. A number of metallic salts of abietic were next prepared, by adding the aqueous solution of the metal salt to one of sodium abietate. Thus, lead abetiate, Pb $(C_{20}H_{29}O_2)_2$; Manganese abietate $Mn(C_{20}H_{29}O_2)_2$; the chromium and iron salts both contained an excess of abietic acid, but more successful results were obtained by using alcoholic solutions.

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL INSTITUTION.

A General Meeting of the members of the Royal Institution was held on Monday afternoon (July 3), Sir James Crichton-Browne, Treasurer and Vice-President, in the chair. Viscountess D'Arcy, Miss E. Fairfax, Sir Thomas Fisher, K.B.E., Mrs. Grove-Hills, Mr. J. Hetherington, Mr. A. J. Lambert, Mr. W. F. Roch, Captain Riall Sankey, C.B., Lieut.-Colonel J. A. Stirling, D.S.O., M.C., and Mr. C. Tierney were elected members. The death of the Prince of Monaco, an honorary member of the Institution, was announced, and a resolution of condolence was passed.

MINERALOGICAL SOCIETY.

June 27.

Dr. A. Hutchinson (President) in the chair.

A. Brammall and H. F. Harwood: *The Dartmoor Granite; its accessory minerals and petrology.*

Minerals of general occurrence: tourmaline, ilmenite, magnetite, apatite, monazite, garnet, zircon (1) in water, clear, small crystals; (2) in tawny, zoned, larger, and more abundant crystals, pyrites and pyrrhotine. More restricted: fluor (colourless, blue and purple), topaz, cassiterite, andalusite, sphene, anatase, barytes. Biotite is abundant; muscovite is scanty. Streams have yielded, in addition, rutile, brookite, and blue-green anatase. Analyses are given of granite types (bulk), biotite, porphyritic felspars (baryta-bearing), and some accessory minerals. The tor area (Haytor-Widecombe) is mapped to show that the granite occurs as successive sheets or flows, differing appreciably in chemical composition. Texture becomes coarser, porphyritic felspars become more abundant and richer in plagioclase content, percentage of biotite and accessories increases with vertical descent in a flow. The relationship of topography to pseudo-bedding, jointing, veining and probable faulting is discussed.

W. F. P. McLintock and F. R. Ennos: *On the Structure and Composition of the Strathmore Meteorite.*

A description is given of the microscopical characters as seen in thin sections of this meteorite, stones of which fell in Perthshire and Forfarshire on December 3, 1917. The structure is that of the intermediate chondrite group (Ci). An apatite-like mineral is present. Detailed chemical analyses of the magnetic and non-magnetic portions agree closely with the Baroti group.

Henry F. Collins: *On some Crystallised Sulphates from the Province of Huelva, Spain.*

Analyses are given of pisanite, chalcanthite, coquimbite, copiapite, voltaite, roemerite, etc., from various pyrites mines. Experiments were made to determine the range of miscibility of iron sulphate and copper sulphate in mixed crystals of pisanate ($RSO_4.7H_2O$) and chalcanthite ($RSO_4.5H_2O$).

Harold Hilton: *The Graphical Construction of the Constants of a Shear.*

A graphical construction, based on the gnomonic projection, is given for obtaining the two circular planes of a shear, when the initial and final positions of two crystal-poles or edges are known.

Harold Hilton: *A Note on Crystallographic Notation.*

A notation is suggested for the 32 crystal-classes and the 230 groups of movements, which is easy to write and print, and is based on the fundamental principles of structure-theory.

A. F. Hallimond (with Chemical Analysis by E. G. Radley): *On Glauconite from the Greensand near Lewes, Sussex; the constitution of Glauconite.*

A boring through 325 feet of Gault at Iford Manor yielded glauconite sand. A discussion of the analysis of this material and of some previously published analyses leads to the formula $R_2O.(4R_2O_3,RO).10\ SiO_2.n\ H_2O$.

L. J. Spencer: *Ninth list of New Mineral Names.*

BOOK RECEIVED.

Sir Edward Thorpe, C.B., LL.D., F.R.S. *A Dictionary of Applied Chemistry,* Vol. III. Pages: VI. + 735. Longmans, Green & Co., 39, Paternoster Row, E.C.4., 1922. Price £3 net.

NOTICES OF BOOKS.

The Calculations of Analytical Chemistry, by Edmund H. Miller, Ph.D. Pp. X + 201. Third edition. London & New York: The MacMillan Company, 1921. Price 9s.

Prof. Miller's useful compilation of the calculations of data and results in analyti-

al and general chemistry and students' exercises thereon, has now reached its third edition.

The calculations include those of the Equivalents, Atomic Weights and Formulæ, Volumetric and Gravimetric Analysis, and Thermochemical and Electrochemical data. The examples are preceded by brief descriptions and the exercises are typical ones. Some of them have been taken from important original papers.

Numerous Tables of Chemical, Physical and Mathematical data are given at the end. (A more recent Table of Atomic Weights than that of 1904 might have been inserted.)

Chemical calculations frequently receive less attention in schools and colleges than they should, therefore Prof. Miller's book merits the careful attention of lecturers and science masters. J. G. F. D.

Metallography, by C. H. Desch, D.Sc. (Lond.), Ph.D. (Würzb). Pp. XI. + 440 + 14 plates. Third Edition. London: Longmans, Green & Co., 1922. Price 16s. net.

Prof. Desch's book on Metallography, i.e., the physical and microscopical study of the internal structure of metallic alloys, has reached its third edition.

The text has been extensively revised, and the subject matter has been brought up-to-date by the incorporation of the recent results obtained in this branch of physical chemistry, especially in connection with corrosion and the metallography of iron and steel. The numerous photo-micrographs illustrating the internal structure of alloys, diffusion of metals, etc., are especially good.

The binary and ternary systems for which equilibrium diagrams have been published are collected in the useful appendix, with the latest references of accurate work in each case.

This volume, which is one of the Textbooks of Physical Chemistry edited by the late Sir William Ramsay and Prof. F. G. Donnan, is deservedly popular, and the present edition will not only be extensively used as a textbook by students, but will also be freely consulted by those who desire information on this subject, which has recently attained considerable importance.

Metallic Alloys: Their Structure and Constitution, by G. H. Gulliver, D.Sc., F.R.S.E., A.M.I.Mech.E., M.Inst.M. Pp. XXVIII. + 430. Fourth Edition. London: Charles Griffin & Co., Ltd., 1921. Price 15s.

The author has described fully the methods for preparing and studying binary and ternary alloys. Various points of theoretical interest are discussed with the help of numerous equilibrium diagrams. The chapter on the microscope in engineering practice is interesting and important.

This edition is substantially the same as the previous one, except that an appendix on the effect of the rate of cooling upon the constitution of binary alloys has been added.

In the preface it is stated that the text is undergoing revision, and that the present edition has been issued to meet the present need for copies of this valuable work.

Modern Microscopy, by M. J. Cross and Martin J. Cole. Pp. X. + 315 + 12 plates. Fifth edition. London: Baillière, Tindall & Cox, 1922. Price 10s. 6d. net.

In this book on Microscopy, revised and re-arranged by H. F. Angus, it is clearly demonstrated that the microscope has been of great service to Science in the elucidation of new facts and in the clear perception of fine structure.

Part I. gives a detailed account of the construction of various microscopes and accessories, with full instructions for their use. A list of Microscopical Societies and Clubs with their Rules is also included in this section.

In Part II., chapters on the uses of the microscope in special subjects have been contributed by various authorities. That on its service in the interests of Public Health, by Dr. W. E. Cooke, is one of the most important, and indicates how analysts are dependent upon microscopical as well as chemical evidence in forming their conclusions. On p. 104 it is stated that in populous districts the staggering total of three million solid particles may be counted in one cubic inch of air. This may include fibres of wool and cotton, mineral dust, and especially numerous micro-organisms, many of them dangerous ones.

Part III. constitutes a popular exposition of the study of various branches of Natural History with the aid of the microscope. In this eminently practical section, complete

details are given for the preparation of slides and the mounting of objects for examination.

The present edition of this handbook has been written more especially for beginners and students, but much of its contents cannot fail to interest more advanced workers.

J. G. F. D.

Modern Chemical Lecture Diagrams, by Dr. Geoffrey Martin, D.Sc., etc., assisted by J. M. Dickson, B.Sc., and Major J. W. Christelow, B.Sc., A.I.C. Pp. 88. London: Sampson Low, Marston & Co., Ltd., 1922. Price 3s. 6d.

The author does not divulge his object in publishing this little book, but presumably it is intended for the use of the students of those lecturers who employ Dr. Martin's large charts of Chemical Lecture Diagrams.

In general, these diagrams are good, and convey a fair idea of the nature of various processes, but that of Pictet's method for liquefying gases, on p. 14, is not at all clear, and the Vapour Density apparatus, p. 20, has lost in clearness by reduction.

Mendeléeff's name is spelt with one f on p. 59, elsewhere it has two. It also seems incongruous to find together on p. 12 the Solubility Curves of Salts and Carbon Dioxide Isothermals.

Lecturers who have used Dr. Martin's Charts will find the present volume useful for reference, and their students will be more easily able to write up their lecture notes with the help of its descriptions.

J. G. F. D.

ERRATUM.

Calcium oxalate in *Acacia Cambagei*. C.N. CXXIII., p. 315. Table of analyses, figures in fourth and fifth lines should be transposed.

A CHEMICAL STUDY OF DOLOMITES.

By Lawrence R. McKay and William A. Moore.

An ideal dolomite, calcium magnesium carbonate, would consist of calcium carbonate, 54.35 per cent., and magnesium carbonate, 45.65 per cent. Possibly such a dolomite has never been found in nature.

The rocks of north-eastern Iowa are dolomites and fairly typical. The analysis of a specimen from near Mount Vernon, Iowa, resulted as follows:—

SiO_2	0.86%
Fe_2O_3	0.60%
Al_2O_3	0.54%
$CaCO_3$	54.25%
$MgCO_3$	43.65%
	100.00%

1. Specimen from Little Falls, New York. Light grey in colour and uniform throughout.

SiO_2	3.96%
Fe_2O_3 and Al_2O_3	0.62%
$CaCO_3$	55.42%
$MgCO_3$	40.44%
	100.44%

The specimen is a fairly typical dolomite. The specific gravity is 2.84.

2. Specimen from Kasota, Minnesota. The colour throughout the mass is light yellowish brown.

SiO_2	9.08%
Fe_2O_3 and Al_2O_3	0.91%
$CaCO_3$	51.80%
$MgCO_3$	38.64%
	100.43%

The rock approaches a dolomite. The specific gravity is 2.72.

3. A specimen from Freiberg, Saxony. A yellowish-grey crystalline deposit on quartz. The analysis shows it cannot be called a dolomite, nor even a limestone.

SiO_2	26.60%
Fe_2O_3	51.41%
$CaCO_3$	4.46%
$MgCO_3$	17.54%
	100.01%

The specific gravity of the entire rock, the crystalline deposit, and the quartz together is 3.52.

Ten specimens from the Austrian Tyrol, the locality where Deodat Dolomieu first studied dolomite rocks and made known their composition.

1. Specimen from Martinswand, Tyrol, Austria. A compact, crystalline, greyish-white variety.

SiO_2	0.10%
Fe_2O_3	1.70%
Al_2O_3	0.00%
$CaCO_3$	49.71%
$MgCO_3$	48.53%
	100.04%

2. Specimen from Andrian Ueberetsch, Tyrol, Austria. White, granular, resembling marble.

SiO_2	0.10%
Fe_2O_3	0.58%
Al_2O_3	0.00%
$CaCO_3$	54.45%
$MgCO_3$	44.84%
	99.97%

The *specific gravity is* 2.71 *per cent. The* specimen is almost a typical dolomite.

3. Specimen from Grossachenthal, near St. Johann, Tyrol, Austria. A grey, compact, non-crystalline variety.

SiO_2	0.20%
Fe_2O_3	0.85%
Al_2O_3	0.00%
$CaCO_3$	53.62%
$MgCO_3$	45.31%
	99.98%

This is an unusually perfect dolomite. The specific gravity is 2.84.

4. Specimen from St. Martin, Tyrol, Austria.

SiO_2	0.20%
Fe_2O_3	0.60%
Al_2O_3	0.00%
$CaCO_3$	51.91%
$MgCO_3$	47.52%
	100.23%

This is a pure white crystalline variety, resembling marble. The analysis shows it to be almost a true dolomite. The specific gravity is 2.80.

5. Specimen from Mauknerbach, Tyrol, Austria; a pink, massive variety, of a pearly lustre, but also containing transparent crystals.

SiO_2	0.48%
Fe_2O_3	0.35%
Al_2O_3	0.00%
$CaCO_3$	53.21%
$MgCO_3$	45.81%
	99.85%

The specific gravity is 2.75. It is a fairly typical dolomite.

6. Specimen from Pinegal, near Bozen, Tyrol, Austria. It is a pure white crystalline rock resembling marble. The specific gravity is 2.70.

SiO_2	0.70%
Fe_2O_3	0.60%
Al_2O_3	0.00%
$CaCO_3$	*84.03%*
$MgCO_3$	*14.76%*
	[illegible]

The specific gravity is 2.70. The specimen is not a dolomite but a magnesian limestone.

7. Specimen from Sonnenvendjoch, Tyrol, Austria; a compact, massive, greyish rock.

SiO_2	3.58%
Fe_2O_3	3.18%
Al_2O_3	0.00%
$CaCO_3$	73.75%
$MgCO_3$	19.59%
	100.07%

The specific gravity is 2.74. The specimen is not a dolomite, but a magnesian limestone.

8. Specimen from Reiterkogel, near Brixlegg, Tyrol, Austria. It is a greyish-white, crystalline, compact rock.

SiO_2	0.35%
Fe_2O_3	3.40%
Al_2O_3	1.85%
$CaCO_3$	52.01%
$MgCO_3$	42.52%
	100.13%

The specific gravity is 2.80. The rock is a fairly typical dolomite.

9. Specimen from Zirler Klamm, Tyrol, Austria. It is a black, massive, compact, heavy rock, and bears a resemblance to quartz.

SiO_2	14.50%
Fe_2O_3	9.50%
Al_2O_3	7.00%
$CaCO_3$	48.55%
$MgCO_3$	20.39%
	99.94%

The specific gravity is 2.80. The rock approximates a magnesian limestone in composition.

10. Specimen from Kloster Alp, Tyrol. It is a grey, compact, massive, hard variety, *one side of which seemed to have been* fused.

SiO_2	0.75%
Fe_2O_3	4.30%
Al_2O_3	3.00%
$CaCO_3$	85.73%
$MgCO_3$	6.19%
	99.97%

The specimen is a magnesian limestone. *The specific gravity is 2.70.*

Cornell College, Mount Vernon, Iowa.

CHEMICAL NOTICES FROM FOREIGN SOURCES

New Properties of Green Chromium Sulphate.—*A. Recoura.*—Green chromium sulphate can exist in a condensed form, and it is then capable of forming complexes with an enormous number of molecules of metallic sulphates. These complexes are very unstable, one factor influencing their stability being the acidity of the solution which prevents hydrolysis, and another and more important factor being the concentration of the solution. There seems to be a very great difference between the properties of the condensed complex $[Cr_2 3 S O_4]_2$ and those of the simple complex, but the author has not yet succeeded in determining the physical constants of the liquids containing them. — (*Comptes Rendus*, CLXXIV., 1922, 1460.)

Furfural α-Methylcyclohexanone and some of its Derivatives, and the Mono and Difurfuralcyclohexanones. — *N. Wolff.*—When furfural acts on α-methylcyclohexanone yellow crystals are obtained, to which the formula $C_{12}H_{14}O_2$ can be assigned. When this compound is subjected to reduction by sodium amalgam, two atoms of hydrogen are fixed at the double bond and the reduction compound which is a yellow oil, has the formula $C_{12}H_1 O_2$. When the original compound is treated with organo-magnesium compounds, bromides of phenyl and *p*-tolylmagnesium, it combines with these organic radicals to give phenyl and p-tolyl α-methylcyclohexanone methanes. The condensation of furfural with cyclohexanone in the same conditions gives two different derivatives, mono and difurfuralcyclohexanone, which can easily be separated by fractional distillation or by their very different solubilities in ether, alcohol and petroleum ether. — (*Comptes Rendus*, CLXXIV., 1922, 1469.)

Crystallisation of Amorphous Tellurium.—*A. Damiens.*—Two theories have been put forward as to the nature of amorphous substances. According to one they are in a metastable condition, their velocity of crystallisation being zero, while according to the other theory, at a given pressure the crystalline state is limited to low temperatures by the amorphous solid state which are thus stable, just as it is at higher temperatures by the liquid state. The *author has studied the allotropy of tellurium in order to throw some light upon these theories. Tellurium was treated with a solution of bromine in concentrated hydrochloric acid, and it was found that crystallised tellurium is attacked very rapidly, while amorphous tellurium is instantaneously dissolved. The heat of reaction was determined in each case, and it was found that, however crystallised tellurium had been prepared, the heat of reaction was the same and decidedly lower than that of amorphous tellurium. The irreversible reaction can always be expressed by the equation:*

Te amorphous = Te crystallised + 2.63 cal.

Thus amorphous tellurium appears to be a *metastable form for which all the temperatures at which the element is solid are lower than that at which it is stable.—* (*Comptes Rendus*, CLXXIV., 1922, 1548.)

Preparation of Dialkylvinyl Carbinols. —*R. Locquin and Sung Wouseng.*—The dialkylethinyl carbinols can be hydrogenated *in presence of reduced nickel to give ethylenic or vinyl alcohols which are mobile liquids boiling at about the same temperatures as the corresponding tertiary alcohols. They form more or less stable* hydrates with water. They possess all the characters of tertiary alcohols. They cannot be etherified satisfactorily, but they readily give crystallised allophanates.— (*Comptes Rendus*, CLXXIV., 1922, 1551.)

SOME NOTES ON THE BEHAVIOUR OF LEAD ACETATE TOWARDS POTASSIUM DICHROMATE UNDER DIFFERENT CONDITIONS.

By Geoffrey N. Ridley.

Experiments show that the behaviour of lead acetate with potassium dichromate is affected by alteration of the conditions under which the two compounds react. The most important conditions are those in which the changing of the liquid or solvent is involved; a liquid must, of necessity, be used if the precipitation is to be examined.

Heat often tends to bring about coagulation of the particles of a precipitate, the actual extent to which any precipitate is affected depends upon its composition. The precipitated lead chromate is only affected in this direction to a small extent wh

thrown down from an aqueous solution of the dichromate at 50° C., but upon being stirred and allowed to settle, the precipitate is in a moderately fine state of division. The precipitate is finer when thrown down from a *weak* aqueous solution at room temperature, than that deposited from a *strong* solution under the same conditions. It is conceivable that the ionic state may have some influence here; it is, however, open to doubt. (For the purpose of examining the precipitates microscopically, a low power objective was found the most suitable as giving a larger surface than a high power objective).

Alteration is made in the speed of precipitation by utilising different solvents for the lead acetate and potassium dichromate. Aqueous solutions of these salts are employed in analysis, in which case the precipitation is rapid and the deposit dense. If, however, clear alcoholic solutions are used, the rate of deposition is reduced to a considerable extent and the precipitated chromate only appears as a slight deposit which makes the liquid more or less turbid. Upon the addition of a little water the lead chromate is rapidly thrown down in the normal way.

In this case the reagents are only ionised to a comparatively small degree, and therefore the precipitation value is not so great as that reached by the use of aqueous solutions. The introduction of water increases the ionisation and the chromate is deposited in the usual manner.

The addition of an alcoholic solution of the dichromate to a solution of lead acetate in glycerol likewise gives only a slight precipitate. Here, again, the reaction is advanced by the addition of water, as shown by the voluminous yellow lead chromate which is produced in the solution when the water is added.

In the case where carbon disulphide is used, the results are indicative of the total inactivity of the liquid. A mixture of the finely powdered compounds, when treated with carbou disulphide, is not affected by the addition of this liquid, and hence no precipitate is formed. No signs of chemical action are observed. For the purpose of causing the dichromate and the lead salt to react, water is always added—the aqueous solution is always used. Hence the water acts as a kind of "link" by which the two compounds are in a position to react. The carbon disulphide does not function as a "link," hence the absence of chemical action.

THE INSTITUTION OF MINING AND METALLURGY.—PRESIDENTIAL ADDRESS

(*Delivered at the recent Annual General Meeting*),

By S. J. Speak, A.R.S.M.

It is the privilege of a President when assuming office to give an address upon any subject that may interest him, without previously submitting his intended remarks to his colleagues on the Council. I hope that I shall not abuse the latitude thus allowed me if I speak on matters concerning the welfare of the Institution instead of some non-controversial subject. I was present at the meeting held at Winchester House in 1892 when the Institution was founded, and I feel that I cannot avoid contrasting the situation then with what it is now, and with what it perhaps ought to be. Hence my remarks this evening will be concerned mainly with the work that the Institution has already accomplished, and with what still remains to be done.

Thirty years ago, the so-called practical miner or smelter was regarded by many people as the most suitable man to place in charge of mining or metallurgical operations. The development of the Witwatersrand Goldfields was no doubt an important factor in the education of the public in mining and metallurgical matters, and towards a better appreciation of the trained engineer. Under the conditions of those days, it is readily understandable that properly-educated mining engineers and metallurgists were not regarded by the general public as professional men in the same sense as they regarded lawyers and medical men, for there was no marked line to enable discrimination between professiona land practical mining engineers.

One of the objects of our Institution has been to make clear the distinction between the educated engineer and the so-called practical one, and this has been so far accomplisbed and become effective that the latter type is rapidly becoming extinct. Civil engineers, mechanical engineers and electrical engineers have in general gained more in public esteem than mining engineers; perhaps mainly because their work is more visible to the average person. We must also recognise that as mining is a business and as mining engineers, besides their professional duties, usually direct also the commercial side of the businesses, they

e often more closely connected with financial transactions than perhaps any other class of engineer, with the result that the professional status of mining engineers is able to be somewhat dimmed. Our Institution, however, concerns itself only with the technics and economics of the mining industry, and as a body is purely professional and only indirectly concerned with the financial side of the industry.

PROFESSIONAL STATUS.

During the past 30 years it has been the endeavour to attract to the banner of the Institution all suitably qualified men who wished to live up to a truly professional standard; but without solicitation or propaganda. President Cox in 1899 said: "I hope in the not distant future, all mining and metallurgical engineers of standing throughout the world will have become enrolled as members." In his Presidential address in 1913, Bedford McNeill said: "I hold no one should be permitted to style himself a mining engineer unless he is qualified to do so, and of his qualifications for mining other than coal, this Institution ought to be the tribunal. . . . What we wish to do is to protect the public on the one hand, and on the other secure an honourable career for ourselves."

In so far as British engineers are concerned, we have now almost reached the stage when we may stigmatize as quacks all those who do not belong to the engineering institution that represents the particular branch of engineering they profess. As you are all aware, our Institution does not represent all classes of mining engineers or metallurgists, but fortunately the most important of the Institutions representing the other classes hold similar views to our own regarding professional standards.

It may therefore soon be possible, in conjunction with such other Institutions, effectively to control the members of the two allied professions. Other Engineering Institutions besides those representing Mining and Metallurgy also suffer from the abuse of the descriptive title "Engineer," and recent events, in which our Institution has taken some part, point to the probability of the formation of a General Engineering Council, which will, amongst other things, take steps to protect all properly-qualified engineers and correlate the work of the several existing engineering societies. A combination of such a kind would attain [illegible] effectively than any Institution could otherwise do singly, and, moreover, in these days of political strife it is most desirable that all professional men should combine for self-protection.

The closer association with the Institution of Mining Engineers that we have recently entered into will no doubt prove of considerable advantage in raising the status of British Mining Engineers in general. Both being chartered Institutions, the public cannot be expected to discriminate between the two, and accordingly both should aim at achieving the same standards of qualification and conduct. That is, I believe, the spirit now animating the two Institutions, and there is every prospect of its being accomplished very rapidly.

PROFESSIONAL CONDUCT.

Under its Constitution the Institution possesses authority to expel a member for unprofessional conduct, and that such expulsions are infrequent is probably due to the careful scrutiny of candidates before admission into the Institution. During the past, many members have asked the Council to formulate rules tending towards a uniform standard of ethics amongst its members. The difficulty of framing a detailed code is that it might imply some disregard of the ordinary principles of honesty and integrity by our members.

What, perhaps, is better than any code that could be drafted, was expressed by W. McDermott in his Presidential Address of 1897: "In view of the peculiar difficulties and temptations of a mining engineer, I think every school of mines should have a department of ethical culture included in the regular course . . . to strengthen the conscience of the student before he is turned loose." Mr. McDermott probably with intention mentioned only the mining engineer, because the metallurgist during his career does not encounter so many of the difficulties referred to.

The student could, I think, also be warned of the pitfalls that may trap the innocent. For example, there is nothing inherently dishonest in owning shares of a mine in which one may be employed; indeed, the idea of workers becoming shareholders is often recommended as a remedy for industrial unrest. It is, nevertheless, very undesirable for an engineer occupying a responsible position on a mine to deal in its shares, because he will probably be suspected of using his information before the other shareholders obtained it. No special

code of ethics is needed to tell a man that it is wrong to misuse the confidence placed in him; but, on the other hand, he should not be specifically forbidden to do a thing which is perfectly honest if done honestly.

Similarly in the case of a mining engineer receiving a percentage of profits; some employers desire such a method of payment, as being likely to create the best results; in later years the engineer, however, may find himself wrongfully accused of neglecting development and maintenance work for the sake of his share of profits.

Though the Institution might usefully point out to its members some of the dangers they may encounter, it would surely be undesirable to forbid a member any transaction, which was honest in itself, for it would pre-suppose that our member could not otherwise perform it honestly.

The matter of "contingent fees" is in some respects a different matter from the two examples I have just given. The simplest and worst form of this, is for an engineer examining a mine to take part-payment of his fee in shares of a company that is to be formed. Young engineers are not supposed to undertake such examinations, and the older ones, who do, are presumed to know the dangers of such procedure.

Every cautious engineer before undertaking an examination, insists on a considerable payment in advance, and the balance on handing in his report, for he knows that in the event of an adverse report, the same will be worse than useless for the objects of an unscrupulous promoter. The latter will often decline to pay for the report and will trump up every possible charge against the engineer in the endeavour to show that the report was unreliable.

Though the Institution has no written code of ethics, any complaints against its members are brought before the Council, consisting of men of experience, and most surely they would regard with grave suspicion any member who had accepted a contingent fee for a report. They would be inclined thereby to believe that any other charges of misconduct brought against him were probably true. Another aspect of the matter is that anyone undertaking work for contingent fees thereby injures his fellow engineers who demand proper payment for their services.

Technical Education.

The Institution has from its commencement attached much importance to scientific and technical education. I need hardly remind you of what it has already done to assist the training of Post-Graduate Students. The value we have placed upon a sound education has always been shown by the conditions of admission to Associateship, and more recently by arranging under our new By-laws that before long it will not be possible for anyone to become a full Member who has not ha da suitable scientific training. By maintaining our qualifications for admission at a high level, we hope that future generations of mining engineers will be freed from many of the difficulties the present generation has encountered, and that whilst assisting to secure a suitable reward for them the more stringent qualifications will also improve the status of the mining industry in general.

In the matter of technical education our Institution has played a prominent part in connection with the Imperial College of Science and Technology, more especially in matters concerning the Royal School of Mines. Our desire from the first has been to see that College recognised as the technological centre of the Empire, which would attract graduates from other colleges and universities throughout the Empire for courses of advanced training and research. Last year there were 52 full-time students at the College who came from the Overseas Dominions of the British Empire.

The work of the College must necessarily be hampered so long as it possesses no power to grant degrees. It is only natural that many students, after graduating at a Dominion University, will feel that they cannot afford the expense of a year's post-graduate course in London unless they can thereby obtain some special hall-mark. Our Institution has already advocated that the status of the College should be raised to that of an Imperial University of Science and Technology. There exists, however, powerful opposition to this proposal, mainly from two sources. First from the University of London, which would naturally like to absorb others in order to strengthen itself, though failing to see the undesirability of a county institution absorbing an Imperial one. We cannot expect a graduate of one of our famed Colonial Universities to be particularly enamoured of a London University degree; therefore any facilities that might be offered to students of the Imperial College to obtain London degrees, would not meet the case.

There are other important objections to absorption of the Imperial College by the University of London, and our Council so long ago as 1914 stated that it was their deliberate opinion that the Imperial College could not possibly achieve the principal purpose for which it was founded, if it became absorbed by the University of London.

The more difficult opponents to be combated are those who have themselves been educated on the classical side of existing Universities. No doubt to them a University of Science and Technology, or indeed any University specifically limiting its teaching to any particular branch of knowledge, is unthinkable. We can respect the views of these opponents, notwithstanding their impracticability for present-day needs, for we do not underrate the value of the older forms of culture. We do, however, protest against the suggestion that a study of the humanities is a higher form of education than a study of natural science. Where time or circumstances do not allow of a proper study of both, it is to be regretted that persons who received their educational training in Arts, with little or no Science, should offer opposition to others who place a greater value on Science, and cannot spare much time for Arts.

(To be Continued.)

DETERMINATION OF ALUMINIUM.

A new method for estimating the amount of aluminium in commercial samples is described by L. Losana in *Giornale di Chemica Industriale ed Applicata.* 0.5 to 1.0 gm. of the metal is heated with caustic potash solution in a flask through which a current of air is drawn. The hydrogen evolved, according to the equation:—

$$2\ Al + 6\ KOH = 2\ Al\ (KO)_3 + 3H_2$$

is first passed through a water cooled condenser into a drying tube containing pumice saturated with strong sulphuric acid. It is then passed through a tube of calcium chloride or phosphoric anhydride into a tube electrically heated to about 200° C. containing palladiumised asbestos. Here it combines with the oxygen of the air, which is continually drawn through the apparatus, and the water formed is collected in two weighed U tubes, one containing $CaCl_2$ and the other P_2O_5. 1 gm. Al corresponds to 0.9964 H_2O. The amount of aluminium can then be calculated.

New Patents.

This list is specially compiled for *Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications:

16651—Baumgartner, E.—Manufacture of chromate of soda. June 15.

16687—Erikson, O.—Soda recovery process in sulphate paper-pulp manufacture. June 16.

16640—Hurter, A.—Method of manufacture of alumina from sulphate of aluminium. June 15.

16197—Jacobson, B. H.—Process of making anhydrous metallic chlorides. June 12.

16528—Jones, T. R.—Process for manufacture of a zinc-oxide substance. June 14.

Specifications Published This Week.

160172—L'Air Liquide, Soc. Anon. Pour l'Etude et l'Exploitation des Procedes G. Claude.—Processes for the production of bicarbonate of soda and of ammonium chloride.

180837—Pike, R. D.—Method of treating magnesite.

Abstract Published This Week.

Hydrocyanic Acid; cyanides. — Patent No. 179096.—Messrs. Air Reduction Co., Inc., of 342, Madison Avenue, Manhattan, New York, U.S.A., have obtained a Patent in this country for a process of obtaining Hydrocyanic acid.

It is obtained from pure or crude cyanides by treatment with carbonic acid, without taking precautions to control the temperature, by removing the gaseous product so rapidly as to prevent polymerization. From one and a half to three times the theoretical quantity of carbonic acid, for example, may be passed through a layer of cyanide in from six to twelve minutes. A reaction vessel on trunnions is provided with a perforated metal false bottom, upon which are several layers of metal gauze covered by a sheet of porous material such as a monel metal filter cloth. The cyanide is ground, moistened, and placed in a layer upon the sheet Carbon dioxide is supplied from a cylinder through a meter, and passes through the charge downwardly. The gases issue by a pipe and pass through coolers, and preferably a compressor to a coil in which the hydrocyanic acid is liquefied. The liquefied acid collects in a store tank and the uncondensed gas passes to a holder and thence returns to the reaction vessel by a pipe. The reaction chamber may be provided with a jacket for removing the heat resulting from the previous charge The hydrocyanic acid may be absorbed in alkalies for the production of pure cyanides.

Messrs. Rayner & Co. will obtain printed copies of the published specifications, and forward on post free for the official price of 1s. each.

THE CHEMICAL NEWS,

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THE BRITISH ASSOCIATION OF CHEMISTRY.

THE UNEMPLOYMENT BENEFIT FUND.

A Special General Meeting of the British Association of Chemists was held on Saturday, July 8th, at the Midland Hotel, Manchester, for confirmation of the Advisory Ballot on the Unemployment Benefit Scheme and for its formal adoption as part of the rules of the Association.

In the unavoidable absence of the President, the chair was taken by Mr. Wm. E. Kay, there being about 50 members present.

The occasion was noteworthy, having regard to the fact that copies of the first monthly issue of the official journal of the Association—"The Bulletin of the British Association of Chemists"—were distributed among those present. It contains an editorial, reports of proceedings from the London, Birmingham and Manchester sections, an article entitled "Educational Facilities for Laboratory Assistants," and an earnest appeal from a writer, giving the initials "F.B.G.," to all members to whole-heartedly support the establishment of the Unemployment Benefit Fund. Many chemists, he wrote, were now out of employment, and, to quote the writer's concluding words—"It may be your turn next."

The Chairman, in outlining the nature of the business to be transacted, said that an attempt was now being made to help, out of a common purse, those among them upon whom there were serious and urgent calls. Although they had taken the best professional advice they could, yet the Unemployment Benefit Fund Scheme was somewhat tentative in the sense that there was still very little known as to how unemployment among chemists stood in relation to general unemployment. There were no actuarial figures available which would give them the means of putting forward a cut-and-dried scheme. Therefore they had had to prepare one which had in it elements of elasticity, and they had endeavoured to prepare, under certain aspects of the scheme, means of meeting special contingencies. In a preliminary way, the feeling of the members had been tested and had proved to be emphatically in favour of the establishment of a scheme. Only 14 per cent. objected to it. The course that he intended to pursue in the conduct of the meeting was to put before them two resolutions:

(1) "That this meeting confirms the result of the ballot on the Unemployment Benefit Fund Scheme, and hereby authorises the Council to proceed with its registration as an addition to the rules of the Association."

(2) "That the rules for the Unemployment Benefit Fund be put into immediate operation, and that subscriptions to the Fund be payable as from 1st July, 1922."

The Chairman then formally moved the first resolution.

Mr. Harrison, as Secretary of the Fund Committee, seconded. He thought they would all agree with him when he said that this was the greatest economic scheme which had ever been placed before chemists. The Council and the Committee which had been charged with its preparation had done their best to make it a success. It was one which should be part and parcel of the first ideals of the Association. No one could possibly have any objection to its principle. Their organisation was an economic body banded together for the purpose of looking after each other's interests. The scheme was not a stunt for councillors to seek re-election on, and it was not one by which any member could take advantage of another. It would benefit the Association in many ways, financially and socially, and he was convinced that in the future the fortunes of the Association would largely depend upon it. Most of them had noticed at some time or other some great commercial undertaking, which had been moving forward slowly, suddenly burst forth into great prosperity. When they came to consider why this was so, they found that it was due in the main to the accumulation of much capital. Speaking for themselves, they did not want to gain capital by increasing subscriptions, but by gaining members. If they gained members they would obtain all the capital they required, and without capital they could not go forward as an Association.

The new rules embodying the scheme were then considered in detail. They were 18 in number.

Dr. Foster enquired whether the scheme could be made applicable for probationers to voluntarily join it.

It was stated that, under the rules in their present form, this could not be done, but if thought necessary some provision could be made in that direction.

Mr. R. Brightman suggested that before dealing with any question of probationers they should obtain fresh actuarial advice.

Dr. Foster said that his question was merely intended to be suggestive, and the Chairman promised that the Committee would consider the point.

Rules 2 and 3 provide that the Fund shall be administered through a Special Purposes Committee appointed by the Council, and shall include the Trustees of the Association, and that the benefits paid shall be upon a "unit system" and shall vary in accordance with the number of units of contributions taken up.

Rule 7 was considered in the following form:—

(7) The maximum number of Units for which a Member may subscribe shall be dependent on age and in accordance with the following Schedule, except in the case of a married member, who may take up one extra Unit:

Age at joining.	Benefit per week for each Unit subscribed.	Maximum No. of Units for which a Member may subscribe.
21-30	20/-	3
31-40	20/-	4
41-46	17/6	6
47-60	15/-	6

Rule 8 was also considered in the following form:—

(8) Members ceasing to be employed in so far as their main employment is concerned, but who may be earning fees or other remuneration in respect to teaching or other part-time employment, either day-time or evening, shall receive benets in accordance with the following scale:—

Earnings from part-time employment as above.	Rate of benefit payable.
Not exceeding 30s. per week.	Full benefit.
Exceeding 30s. per week but not exceeding 50s. per week.	Three-fourths
Exceeding 50s. per week but not exceeding 75s. per week.	One-half.
Exceeding 75s. per week but not exceeding 105s. per week.	One-fourth.
Exceeding 105s. per week.	Nil.

Rule 10 provides that no benefits shall be payable during the first month of unemployment, and Rule 11 that in order to provide a nucleus for the Fund no benefits shall be payable during the first six months of the operation of the scheme. Members joining the Fund after the date of the Scheme first being put into operation will also not be eligible for benefit until six months from the date of their first subscription. Rule 13 makes provision for any member being suspended from benefit owing to his own misconduct.

Rule provides, after the auditors have certified that the necessary Reserve Funds have been established, that 75 per cent. of the surplus funds may be distributed as a cash bonus.

The whole of the Rules having been discussed, and necessary textual alterations having been made, they were confirmed in the terms of the first resolution.

The Chairman then moved, and Mr. Redgrove seconded, the adoption of the second resolution, which was carried unanimously.

A general discussion then took place in the course of which Mr. A. S. Mills gave an account of the working of the Unemployment Bureau and of the rebates which were now allowed by the Income Tax Commissioners in respect to damaged clothing, &c. Closer co-operation with the N.U.S.W. was also advocated.

NOTES.

The Library of the Chemical Society will be closed for stocktaking from August 7th to August 19th, and will close each evening at 5 o'clock from August 21st to September 16th.

In this week's *Manchester Guardian Commercial* is given a description of "Arghan," a new textile fabric for which much is claimed. Originally discovered in the leaves of a plant akin to the pineapple growing in the South American wilds, the difficulties of transport were at first in-

ıperable. So a large quantity of roots ere conveyed to the Federated Malay tates, where the F.M.S. Government, oreseeing the fibre's potential value, imıediately set apart 30,000 acres for its evelopment. Now the Ceylon and Indian overnments propose to grant similar large acts. Arghan is past its experimental ages, since not only magnificent fibre, ut a beautiful firm cloth is being made om it. No great preparation is needed, r the broad leaves, without any degumıing or retting, split up into innumerable arly white silky fibres. Their merits are stonishing, being actually 50 per cent. ronger than hemp, extending to six feet more and adamant to sea-water. Both ıe cloth and the yarn take dye permantly, and it is opined by experts that if ıe fibre can be produced at lower cost ıan similar flaxen or hemp fabric, it must val them in use.

Messrs. H. & K. Lewis & Co., Ltd., have nt a copy of their list of College Text ooks and Works of Reference on Science ıd Technology for 1922.

The subjects are arranged in alphabetical der from Agriculture to Zoology, and inude a very complete list of books on hemistry, with dates and present prices. The list can be obtained by application the Publishers.

The summer issue of the *Chemist and ruggist* has just been published, and is ighly creditable production. In addition a volume of matter of importance to the harmacist, a large number of striking adrtisement pages are given, some of riking originality.

DEHYDROTHIOTOLUIDIN: ITS ISOMERS, HOMOLOGUES, ANALOGUES, AND DERIVATIVES.

By MARTIN MEYER, B.Sc., M.A.
NEW YORK CITY.

(Continued from Last Week).

Preparation of Pure Dehydrothiotoluidin.

As a result of the work described, the ollowing procedure for the preparation of the pure compound was arrived at. This method, unlike any of the previous ones found in the literature, is complete as far as laboratory directions are concerned, will work exactly as recorded, and was used for the preparation of considerable quantities of the pure base.

110 g. of paratoluidin and 60 g. of powdered roll sulphur are heated from 4 to 6 hours in a one litre flask equipped with a reflux air condenser on an oil bath at 220°. At the end of this time the melt is poured out into an evaporating dish or a mould made of the lid of a flat paper or wooden box, and powdered after cooling. It should weigh about 100 g., depending on how much can not be poured from the flask, but not more than this is used in the subsequent distillation.

The distillation is then conducted in the apparatus in Fig. 3, following the directions and precautions already given. The product is recrystallised once from 96 per cent. ethyl alcohol which gives 22-25 g. of yellow needles melting at 192-193° C. (cor.). Further recrystallisation and boneblacking will yield it still paler in colour and melting at 194.8° C. (cor.) as already described.

9. *Benzal-Dehydrothiotoluidin.*

To a saturated solution of dehydrothiotoluidin in alcohol, add the calculated amount of benzaldehyde from the equation:

$$C_{14}H_{12}N_2S + C_7H_6O = C_{21}H_{16}N_2S + H_2O.$$

Heat to boiling for a few minutes and allow to stand to crystallisation. The yield is practically quantitative, and this method may be conveniently used to recover the base from the solutions remaining from its purification, as the condensation product is much less soluble in 96 per cent. ethyl alcohol than the dehydrothiotoluidin itself. Recrystallise the product from alcohol in which it gives a pale yellow strongly fluorescent solution, and from which it appears in very pale yellow, odourless, glistening plates melting at 193° C. (cor.).

Calculated for $C_{21}H_{16}N_2S$	S=9.76%
Found	S=9.80%

10. *Dehydrothiotoluidin in the Atophan Reaction.*

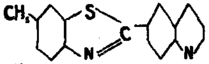
Dehydrothiotoluidin being a primary amine should condense with benzaldehyde and pyruvic acid to give a methyl benzothiazolyl atophan similarly to the reaction

which Döbner and Giesiecke[78] found that aniline underwent. The reaction was therefore tried following this method, but substituting the molecular quantity of the sulphur base for the aniline. The benzaldehyde condensation product was isolated from the reaction mixture, but no new compound corresponding to atophan was found, although small amounts of an amorphous brown material soluble in toluene, but insoluble in sodium carboniate and hydroxide, were formed.

The experiment was repeated, using the benzal-dehydrothiotoluidin instead of the two substances individually, but after 24 hours' heating practically all of the material was recovered unchanged, although small amounts of an amorphous, highly insoluble brown material were formed. Dehydrothiotoluidin apparently will not condense to form a substituted atophan.

11. 6 (6-*Methyl Benzothiazolyl*) *Quinolin.*

Like other primary amines, dehydrothiotoluidin should condense with glycerine in the presence of sulphuric acid and an oxidizing agent such as nitrobenzene,[79] arsenic acid, [80] ferric sulphate,[81] etc., to yield a quinolin of the structure:



if the reaction proceeds analagously in this case.

The method of Skraup was first used, it having previously been found[82] that practically no quinolin results from reaction of the reduced nitrobenzene during the reaction. 56 g. of crude Casella dehydrothiotoluidin and proper molecular quantities of the other substances, were heated according to the directions. The reaction mixture turned red at once, and a reddish, oily tar formed on the surface as the reaction proceeded, a yellow solid forming on the bottom toward th end of the reaction when the mass becam very viscous and boiling slowed up. Th mass solidified on cooling, 300 cc. of wate were added, and it was distilled with stear to remove the nitrobenzene. The residue i the flask was neutralised with warm sodiur hydroxide, filtered and dried, and distilled i vacuo, as it was expected that the new com pound would probably be a solid because c its high molecular weight, and comple structure, a conclusion which was later jus tified. A small amount of yellow solid dis tilled over with a vile smelling liquid. Th solid was filtered off and dissolved in con centrated hydrochloric acid, from which i was precipitated with water. It was recrys tallised from hot alcohol, and the red fluorescent solution deposited small ligh brown crystals (1 g.), with a tobacco-lik odour, melting at 142° C. (uncor.).

The use of the crude dehydrothiotoluidi was thought, however, to offer too man other possibilities, so the reaction was re peated using pure material, and followin the method of Kneuppel, with appropriat modifications for the different physical pro perties of the new substance, which was ex pected to give a better yield.

15 g. (0.07 moles.) of pure dehydrothio toluidin is dissolved in 20 cc. of concen trated sulphuric acid which is slightly mor than the amount necessary in the origina method, but is required because of the phy sical properties of the amine, and 21.7 g. o glycerine and 10.6 g. of arsenic acid wer added to the solution in a one litre flas equipped with an air condenser. The larg flask is necessary because the reaction i vigorous and the mixture foams up and wil run all the way up the condenser otherwise. The mixture is heated, is red at first, bu vigorous ebullition soon begins and continue even if the flame is removed, and turn brown as the reaction proceeds, the mixtur foaming up. The temperature is kept con stant at 190° by means of an oil bath. Sto heating after 1½ hours, cool, and add 500 cc of water. Continued shaking gives a dee brown solution that appears homogeneous.

Neutralise with solid sodium hydroxide. The solution becomes light brown at th neutral point, and deposits a black, tarr material, which is involatile and cannot b distilled with steam.

Filter off and dry the black solid. Disti in vacuo in the apparatus designed for dehy drothiotoluidin. The mass melts, and th product distils over around 250° C. at 4

78. Döbner and Giesiecke, *Ann.*, 242, 291 (1887).
(See also Garzarolli and Thurnlackhi, *Berichte*, 32, 2276 (1889).
Pfitzinger, *Jour. Pr. Chem.* (2), 38, 583 (1905).
79. Skraup, *Monatshefte*, 1, 316 (1880).
Wiener, *Monatshefte*, 2, 141 (1881).
80. Kneuppel, *Berichte*, 29, 709 (1896).
81. Barnett, *Chem. News*, 121, 205 (1920).
82. During an unpublished synthesis of ortho-tol-quinolin.

am. pressure. A small amount of water nd thiophenols distils over with it, and the roduct is therefore crystallised from ethyl lcohol in which it gives an orange-red uorescent solution. Methyl-thiazlyl-quinon appears in microscopic pale brown crysals melting at 147° C. (cor.). The yield is .5 g. or 15 per cent. from the equation:

$C_{14}H_{12}N_2S+C_3H_8O_3 = C_{17}H_{12}N_2S+4H_2O$.

he product was identical with that obtained ı the first experiment, and has a charactertic faint tobacco-like odour.

Qualitative analysis showed the presence f carbon, hydrogen, nitrogen, and sulphur, nd the compound was analysed for sulhur.

Calculated for $C_{17}H_{12}N_2S$ S = 11.59%

Found S = {11.69% / 11.61%

The new base is a typical quinolin, and lds methyl iodide directly, a mixture of qual moles of this and quinaldin methiode reacting in the presence of caustic alali to produce a substance of a deep urple-red colour, analagously to quinolin self. The product is probably of the 'anine type, and it would be interesting to vestigate the further condensation of ethylbenzothiazolyl quinolin methiodide itb this, lepidin, other substituted quinos, as well as with 2-methyl-benzothiazole hich Hofmann, as has already been menoned, observed to undergo similar retions.

DISCUSSION AND CONCLUSIONS.

1. The thiazole structure does not apar to function as a chromophore, or at ast, functions very poorly. A large umber of benzothiazoles have been deribed in this paper, and they are reprentatives ones, of which as has been seen, e large majority, even of those which ntain groups which are ordinarily acpted as auxochromes, such as the hyoxy, the hydrosulphide, methoxy, ethoxy, tro (which is also a chromophore), etc., e colourless, and the remainder in a pure ate are only faintly coloured, as dehydroiotoluidin, and are not dyes. The primuls and chromins are exceptions, but do t furnish a valid objection to this conusion, as their structure is not yet estabhed. In the dyes of this series, it is erefore concluded, the chromophore must the azo or other group, though the thiale structure may, and probably does play important part in modifying the colours tained.

2. The thiazole structure is not an odorophore. The odoriferous compounds, as may be seen from Hofmann's work and other investigations described herein, are closely related to the mother substance, benzothiazole, and the farther we get from this by substitution, the fainter the odor becomes. In the odorous compounds, as has been previously observed, the smell is strongly suggestive of pyridine and the other nitrogen bases, and appears to be associated with the tertiary nitrogen atom. This is further borne out by another fact developed in this paper. Dehydrothiotoluidin is odourless, but the benzothiazolyl quinolin synthesized from it has again the typical plant-base odour somewhat resembling nicotine, which it acquires on the introduction of the second tertiary nitrogen atom. The peculiarly aromatic odour of "Rosenkörper" is hence a purely fortuitous circumstance and indeed, the odour of this when in a pure, dry state is very faint, and it requires some stretch of the imagination to be reminded of "tea-roses and geraniums."

3. The commercial methods by which dehydrothiotoluidin is being prepared at present give yields of the base which do not exceed 35 per cent., and some of this must necessarily be lost in subsequent purification. From the work done in this paper, the direct separation of dehydrothiotoluidin and primuline, if formed in the same mixture with other substances, does not seem to be possible (other than by distillation) if by such a method is meant one which will give large yields of the base in a state of purity indicated by good crystalline form, and a melting point of 191° or over. The problem must be solved by the discovery of a method of synthesis which will avoid entirely the simultaneous formation of primulin, if it is to be solved at all.

SUMMARY.

1. A fairly complete resume of previous work in the benzothiazole field has been given, the chief contribution of the investigators noted, and some attractive lines for further research have been indicated.

2. The following new compounds have been prepared:—

2 Paratolylbenzothiazole.
Nitroparatolylbenzothiazole.
Aminoparatolylbenzothiazole.

22 azo dyes from aminoparatolyl benzothiazole.

Tri (2 anilinobenzothiazolyl) carbinol.
Di (2 benzothiazolyl) fuchsone benzothiazolylimine.
Primulin azo benzolyene urea.
Paranitrobenzal paratoluidin.
Benzaldehydrothiotoluidin.
6 (6 methyl benzothiazolyl) quinolin.

3. From the consideration of about one hundred compounds of the benzothiazole group, including those prepared in the course of this work, and others described by previous workers, it has been concluded that the thiazole structure is not a chromophore.

4. Of all the compounds given, only seven have characteristic odours, and only one has one which differs from what we should expect from structural considerations of genetic relationship. It is therefore concluded that the thiazole structure is not an odorphore.

5. Apparatus has been developed and a laboratory method has been given for the preparation of dehydrothiotoluidin in a state of purity, which, judged by its melting point (194.8° C., cor.), has not been attained by previous workers, and a critical study has been made of the reactions and processes by which it is being obtained at present.

[The Author wishes to append a note of thanks to Prof. M. T. Bogert, of Columbia University, under whose direction the work was done, and to Prof. W. L. Prager, of the College of the City of New York, in whose laboratory some of the analyses were performed.]

Miscellaneous References.

For patents dealing with azo dyes from dehydrothiotoluidin and others see:

Friedländer, "*Fort. der Theerfarbenfabrikation*" (all volumes).

Winther, "*Patents in Organic Chemistry.*"

For general information regarding sulphur dyes:

Cain and Thorpe, "*Dyestuffs and Intermediates.*"

Knecht, Rawson, Lowenthal, "*Manual of Dyeing.*"

Fay, "*Coal Tar Dyes.*"

Richter Lexicon, Beilstein, Schulz and Julius, etc.

DEFINITION OF RELATIVITY.

(Two Supplementary Notes).

By F. H. Loring.

These two notes are a continuation of my article in this Journal of June 30th, 1922, page 381.

1. The relative principle may be indicated by the following statement, bearing in mind of course the obvious fact that the exceedingly rapid movements of the observer are impossible in practice, but they will serve to illustrate the principle (an actual case is given in Note 2 below):—If I look squarely at a picture, it looks normal and its frame appears to be, say, 3 feet by 3 feet. This is a stationary view. If, now, I am rushing with a prodigious speed past the picture, its frame should appear, say, 2 feet wide by 3 feet high. If, again, I am rushing past it with the velocity of light, the right-hand edge of the frame will be seen to merge with the left-hand edge, and if anything at all then can be seen, it would only be a *line*. This is what happens when the Lorentz equation is applied to the problem of relative motion; for, when $v = c$ the equation $= o$. If, as another consideration the velocity of light only were infinitely great, the quotient (v^2/c^2) would become infinitely small, and there would be no change from unity in the equation; and this is what happens when Newton's theory, or the Galilean transformation, is used; or, in short, when "things" are instantaneously extensive there is no change of time or length due to relative motion: the picture does not appear narrower to the fast-moving observer. Einstein (his book, page 33) says: "The Galilei transformation can be obtained from the Lorentz transformation by substituting an infinitely large value for the velocity of light c in the latter transformation." Adhering to the Lorentz transformation and working with *low* relative velocities it gives answers practically agreeing with Newton; and, when the stationary observation is made, the agreement with Newton (still using the Lorentz equation) is *exact*. Thus it will be seen that the equation meets all cases, and its form has *not* to be altered to suit extremes. The velocity of light (c) becomes a limiting factor in the equations. This equation, as given in the second paragraph (p. 382) merely represents the projected length of

:n by virtue of the relative movement, ıether this be *length* (which becomes ortened) or *time* (which becomes lengthed); and this is a problem of simple geo:try. Pondering over these matters, we : led to expect the velocity of light to be a fundamental nature; so fundamental, fact, that the particular velocity (c) inlved could not be strictly limited to one pe of phenomenon, such as the propaga-n of light or electromagnetic waves. A otation from Eddington's book, "Space, me and Gravitation" (pages 94 and 60), ll suitably close this note. "Finally, is e force of gravitation propagated instanıeously, or with the velocity of light, or me other velocity? Until comparatively :ently it was thought that conclusive oof had been given that the speed of gra:ation must be far higher than that of ht. . . . In the theory given in this ok, gravitation is propagated with the eed of light, and there is no discordance th observation." Furthermore, "on the ıole, the evidence seems to be against e existence of anything moving with a eed beyond that of light."

2. The following, taken from Eddingn's *Romanes Lecture* (1922) on the ıeory of Relativity* will help to make the finition of relativity clearer:—"I will nclude this part of the argument with an perimental application which illustrates e power of Einstein's method. Much ıdy has of late been given to electrons oving with very high speeds; for example, e β-particles shot off from radio-active bstances are negative electrons which metimes attain speeds of 100,000 miles a cond. It is found by experiment that e rapid motion produces an increase of ıss of these particles. I want to show at the theory of relativity gives a very nple explanation of just how this increase mass occurs. But I must first remark at an explanation had been previously ven which had generally been accepted as tisfactory. The phenomenon was actuy predicted by J. J. Thomson before re:ivity was thought of; because, assuming at the mass of a β-particle is of electrical igin, an application of Maxwell's equaons shows that it ought to increase with locity. But the precise law of increase nnot be predicted on this basis, since rious plausible assumptions lead to ghtly different results. Moreover, Maxell's equations are, after all, only empiril laws, with a mystery of their own; it is a notable advance to connect the change of mass at high speeds with other phenomena whose strangeness had disappeared by long familiarity, but there is still scope for a more far-reaching explanation. Einstein takes us straight to the root of the mystery, and he clears up one point which was misleading, if not actually wrong, in the older explanation. The change of mass does not in any way depend on whether the mass is of electrical origin or not; it arises simply from the fact that mass is a *relative* quantity, depending by its definition on the relative quantities, length and time. Let us look at the β-particle from its own point of view; it is just an ordinary electron in no way different from any other. But it is travelling unusually rapidly. 'That,' says the electron, 'is a matter of opinion. So far as I am aware I am at rest if the word *rest* has any meaning. In fact I was just contemplating with amazement *your* extraordinary speed of 100,000 miles a second with which you are shooting past me.' Of course our motion is of no particular concern to the electron, and it will not modify its constitution on our account; so it keeps its mass, radius, electric field, &c., equal to the standard constants applying to electrons in general. These terms are relative, and refer therefore to some particular frame of space and time—clearly the frame appropriate to an electron in self-contemplation, viz., the one with respect to which it is at rest. But this frame is not the usual geocentric frame to which we refer quantities, such as length, time and mass; there is a difference of 100,000 miles a second between our station of observation and that of the β-particle in self-contemplation. It is a mere matter of geometry to discover what the β-particle's lengths and times become when referred to the partitions which we have drawn across the world. But when we calculate the consequential change of mass resulting from the changes of length and time, we find that it should be increased in precisely the proportion indicated by the most refined experiments. The point is that every electron, at rest or in motion, is a perfectly constant structure; but we distort it by fitting it into the spacetime frame appropriate to our own motion with which the electron has no concern. The greater our motion with respect to the electron, the greater will be the distortion. The distortion is not produced by any physical agency at work in the electron; it is our transformation of the reference frame purely subjective distortion depending on

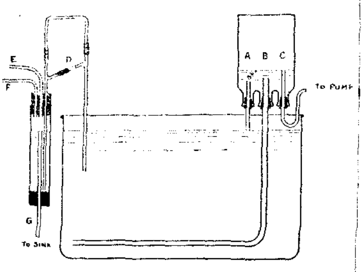
of space and time. This distortion involves a change in our physical description of the electron in terms of mass, shape, size; and in particular the change of mass agrees precisely with that found experimentally."

* Page 19: pamphlet published by the Clarendon Press.

AN APPARATUS FOR STIRRING A BATH USING WATER POWER.

By C. H. D. Clark, B.Sc., and G. T. P. Tatham, B.Sc.

The following device for stirring the water in a thermostat has been found very useful in a place where electric power was not available:—



The main part of the apparatus (see Figure) is a three-necked bottle, of capacity about 500 cc., supported in an inverted position over the bath, as shown. The three necks are corked and carry tubes, A, B and C. A is a short straight tube, diameter 3 mm., just reaching the surface of water in the bath; B is a wider tube, diameter 1 cm., arranged as shown; C is connected to the filter pump and terminates within the bottle, about 5 cms. above the neck. On exhausting the bottle by means of the pump, water rises until the lower end of A is uncovered, when air enters in a stream of bubbles along with water which passes down the tube B, and so maintains a constant circulation in the bath. Incidentally, the level of water in the bath is prevented from rising above the lower end of A, any excess of water being removed by the pump.

The level of water in the bath is kept up to the lower end of A by the constant level arrangement shown on the left of the diagram. This consists essentially of a siphon tube D, made up of two bent T-pieces connected by rubber joints with each other and with another connected above, as shown. By this means, breakage of the siphon by air bubbles is prevented, as they collect in the top of D, and are removed periodically by blowing down the tube E. Water must be arranged to enter in a slow stream from the tap by the tube F, and to overflow through the wider tube G, the upper end of which is very slightly above the lower end of A. The correct position for G is found by experiment, starting with it below the position, and gradually raising it until the water in the bottle just maintains itself at the level of the top of the tube C when equilibrium is attained. In practice, it is better to have both parts of the apparatus supported on the same stand, so that they always remain in the same relative position; also to turn the bottle through 90° from the position shown to economise space in the tank, the positions in the diagram being for purposes of clearness only.

A fairly small suction at the pump will usually produce effective stirring. This can be found by trial, introducing, if necessary, a little coloured liquid at the lower end of A, and watching the circulation set up. In conjunction with a good thermostat, there was to be found a maximum deviation of temperature in different parts of the tank of ± 0.1° C. By modifying the levelling arrangement, the device could be used for liquids other than water in the bath. On introducing or removing an object into or from the bath, a change of level occurs which may slightly upset the temperature adjustment, but equilibrium is again attained fairly quickly.

The device described above appears to be better for the purpose than the use of a water turbine in economy of power, and in that it can be quickly set up anywhere from first-hand materials at low cost, and that there is no complicated mechanism to go out of order. The apparatus has been left running during a set of experiments lasting several weeks, and was found to continue to work satisfactorily, the temperature remaining constant. It possesses advantages over the plan of bubbling air through the tank in efficiency of stirring, and in that the liquid is not irregularly or violently agitated, a regular circulation being set up.

THE INSTITUTION OF MINING AND METALLURGY.—PRESIDENTIAL ADDRESS,

(Delivered at the recent Annual General Meeting),

By S. J. Speak, A.R.S.M.

(Continued from Last Week.)

My remarks thus far on the subject of technical education have all been in respect of the work the Institution has done for others, but the Institution also does direct work for its own members. As said by J. H. Collins in his Presidential Address in 1895: "One great reason for the establishment of this Institution is the fact that from the nature of the case the education of the mining engineer and the metallurgist is never completed nntil his career is ended. . . . We meet and discuss and publish so as to learn from each other and teach one another."

Our publications are read with great interest by most of our members; some, perhaps, consider that they are not always up to the desired standard of excellence. The war has no doubt had some detrimental effect on our publications, both by disturbing the occupations of our members and by increasing the cost of printing, so that we have some reason to hope for a larger number of valuable contributions in the near future. It must, however, always be remembered that the Institution cannot publish epoch-making papers if our members do not send them to us. Unfortunately there is a type of member who never writes, but demands good reading, and often this same type believes that the sole duty of the Institution is to publish technical information. My Address will, I hope, induce such to take a broader view of the work of the Institution.

Overseas Members.

Our Institution is unique amongst technical institutions in regard to the proportion of its non-resident members. A considerable number of our members are resident in Dominions possessing technical societies of their own. Our last thought is to do anything but to encourage and strengthen such local societies in every way, though at the same time we must maintain the interest of all our members in our own work. With this object a number of Overseas Committees were constituted recently, and some have already done very useful work, notwithstanding the limited powers it is possible, under its Charter, for the Institution to delegate to them. The situation, in some respect, is rather a delicate one. It is readily understandable that a member residing, say, in Johannesburg—where there exists an excellent technical society—may feel inclined to save payment of our annual subscription. Being occupied for the time being only in the production of gold, he may not feel interested in many of the papers that we publish. He will, however, secure many of the benefits of the work we are doing for the good of the profession in general without subscribing towards our costs.

In this connection I would like to recall the reports of the Institution on "Ore in Sight"; "Mesh of Wire Cloth"; "Mine Accounts and Cost Sheets"; etc., all of which have proved useful to the profession in general. The valuable report on Mine Accounts and Cost Sheets has not yet received the general recognition that it deserves, possibly because the mining engineer is often not the arbiter of the form in which his company's accounts shall be prepared, and also because a logical system of accounts is hampered by the requirements of taxation authorities. Standardisation work of the above nature must, in order to be successful, be initiated by a central and influential body.

Overseas members do miss some of the amusement which they would occasionally get by attending our meetings. The discussions as printed and circulated are, very properly, edited to soften all remarks that might seem offensive to the author of the paper under discussion, and also they are curtailed and shorn of non-essential matter. During my term of office I would like to see free verbal discussion as in the past, but would impress upon those taking part, to revise and condense their remarks as drastically as possible for publication. It is not always sufficiently understood that the Institution does not undertake to publish every contribution to a discussion that may be submitted, neither is it at liberty to modify materially any such contributions without permission from the writer, which may be difficult to obtain should he reside at a great distance. I ask therefore, that all submitting contributions to discussions for publication should remember to cut out every unnecessary word, and thereby spare the time of readers. As our discussions are always of great value, some-

times more valuable than the paper discussed, we encourage discussion but advise brevity.

The chief object of my Address this evening is to place the work of our Institution before our overseas members in better perspective than they can be expected to have from a great distance. The mining engineer must at some time or other wander over a considerable part of the globe if he is to gain a comprehensive knowledge of his subject. He may feel happy in his present occupation, but in time he will desire a wider experience, and then he will more readily appreciate the benefits of membership of this Institution. We are cosmopolitan in character, and have undertaken work for the general benefit of the profession which no local society could accomplish.

In the Council's Report for the year 1920 one of the objects of the Overseas Committee is stated to be:

"The increase in the roll of membership by securing the inclusion in it of all who possess the necessary qualifications, to whom the advantages of belonging to the central professional body should be obvious, without diminishing but rather increasing their interest in and service to the kindred local societies."

Our Institution has at no time canvassed for new members, for the reason that it would be unfair to press a man to join and then be stringent about his qualifications for admission. We intend to continue our careful scrutiny of candidates, but at the same time strongly desire all qualified engineers to join our organisation, in order that we may safely say of any Britisher who is not a member, that he is not one for the reason that he does not possess the necessary qualifications.

As we are practically in that position to-day, it is most desirable that any member knowing any qualified engineer should impress upon him the importance and desirability of his joining us. We cannot offer him such direct material benefits as a trades union can, if for no other reason than that the conditions of occupation of our members are so diverse that it would be impossible for us to attempt to lay down scales of fees and salaries. However, by supporting the Institution the gulf between the qualified and partially-qualified is enlarged, and this must tend in matters of employment to the benefit of those who bear our stamp of recognition.

THE METALLIFEROUS MINING INDUSTRY.

Though London is the most important centre of this industry, there exists no organisation to represent the industry as a whole.

There are Chambers of Mines representing various districts, but without means of acting collectively. Our Institution directly represents only the professional men engaged in the industry.

On our suggestion a Joint-Committee was formed in 1916, representative of the principal mining companies whose headquarters are in London, for the special purpose of action in respect of new taxation then being imposed. This Committee did effective work with regard to Excess Profits Duty and the incidence of Income Tax as applied to mines. The Committee made representations to the Royal Commission on the Income Tax in 1919 with regard to the recognition of mines as wasting assets. Hitherto the only wasting assets for which an Income Tax allowance was made were plant and machinery and certain buildings that contain plant and machinery.

The Commission recommended (1) that when a British company purchased from a foreign resident the right to work a foreign mine, that an allowance should be made for the amortization of the capital sunk in the purchase; (2) that an allowance should be given in respect of all inherently wasting assets which have been created by capital, such as buildings and foundations, surface works . . . shaft sinkings and initial work of development. The allowances recommended are not, however, equivalent to the full amortization of the capital sunk. Some other lesser injustices from which mining has suffered are also recommended to be alleviated.

I understand that the Government intend to adopt these recommendations, and will introduce them when a newly codified Income Tax Law is prepared. There still remain, however, many matters that can only be dealt with effectively by an organisation that can speak for the whole industry with one voice. Our Institution alone could do little to remove the injustices that existing laws impose upon the mining industry, though we are deeply concerned with the prosperity of the industry.

We may, however, I hope, be useful in inducing the formation of an organisation that can represent the whole industry, which will be able to take action in all mat-

ters affecting the economic interests of the industry. Such an organisation could also render valuable services to the public.

I have often been asked by newspaper men why our Institution took no steps to expose a particular mining promotion then before the public which to the initiated was obviously a fraud. We certainly have a duty as a Chartered Institution to protect the public interests so far as possible, but I contend that it is beyond our scope to attempt to decide on the merits of financial transactions. An organisation representing the whole metalliferous mining industry might, however, take action, directly or indirectly, to warn the public against fraudulent promotions, for it is to their own interests that the public should receive a square deal.

In London there are one or two papers which undertake exposures of fraudulent promotions, notwithstanding the legal actions to which they thereby render themselves liable. These venturesome papers do not circulate sufficiently extensively or else it must be that there is a fresh crop of fools born every year. An organisation representing the industry would be more effective.

Another matter that could receive the attention of such an organisation is the effect of double Income Tax. The Royal Commission recommended no change in the existing situation as to double taxation of the same income by the United Kingdom Government and by the Government of a foreign State. This is not only bad for the industry, but for the country generally, for by driving away the financing and direction of many mining enterprises from London, this country has lost many orders for plant and materials that would otherwise have been placed here. The report of the Royal Commission states: "this country imposes a tax on all income *arising* within its borders; it also taxes the income of a person resident here, in whatever part of the world his income may have its origin." The most objectionable feature is that in practice it is held that if a company is registered here, its income *arises* here and is taxable.

An organisation representative of the whole industry might also take useful part in considering the relationship between gold and currencies, instead of leaving this matter entirely in the hands of bankers and economists. Though the effects of the increased production of gold due to the great gold discoveries in California, Australia and the Transvaal are well understood by economists, the probable effects of the present seriously diminishing gold output is apparently being lost sight of.

When the chief currencies of the world are rehabilitated on a free gold basis, the effect of the decreased gold output during recent years will become very noticeable, and will accentuate the difficulties of deflation.

Were it not that the Institution hopes to publish a paper at an early date by one of its members, I would have ventured to explain more fully the reasons why I think that an influential body, such as I am now suggesting, representing the producers of probably more than half of the gold output of the world, could and should let the Government and the public know their views on the situation.

Hitherto the Government has been guided in its monetary policy by financiers and economists; but if, as seems possible these advisers have not attached sufficient importance to gold production, the actual position should be made clearer to them.

It should be noted that the situation concerning the future production of gold is different from that of other metals. The latter were subject during the war, to a large extent, to the ordinary law of supply and demand, whereas gold was artificially controlled. As compared with 1913, the production of gold has fallen off relatively little more than that of lead and tin, and much less than that of zinc and copper. The depression with the base metals has, however, occurred mostly within the last two years, and during the war they enjoyed extra prosperity; but in the case of gold, it has lasted eight years with gradually accumulative effects. Consequently gold production cannot now so readily respond to an increased demand as could the production of base metals.

General.

I cannot close my Address without some reference to the difficult times we are now going through. Even in normal times the members of our profession must be considered as badly paid, if regard be given to the frequent changes of employment they have to make, with consequent lost time and expense of removal. I will not include also damages for health due to bad climates and for loss of many of the amenities of civilisation, since most of us are prepared to accept these as part of the game. Few achieve a salary of £1,000 per annum be-

fore the age of 30, and on the average probably do not remain on one mine more than five years. Then comes a change, often to some other country, with an interval without salary and often with travelling expenses to be paid. To the bachelor this is no great matter, but to the married man such changes entail serious expense, so that the latter usually are unable to save much.

Nowadays, with a production of gold, tin and lead about three-fourths of normal, and zinc and copper about half, it is not surprising that there should be an unusual amount of unemployment amongst members of our profession. This occurs, too, after a period of eight years of greatly increased cost of living, during which salaries have been increased by insignificant amounts, and often not at all.

Our Council have had this state of affairs at heart for some time, and have sought how they could best assist our members. In the first place the expenses of the Institution have been kept down as low as possible, but unfortunately it proved impossible to avoid raising the annual subscription. Next we have appealed to mining companies to do their utmost to find employment for ex-Service men, and many have done what was possible in that direction. Mining companies have, however, like the engineers, themselves been passing through bad times, and accordingly are not in a position to be benevolent. Our best hope lies in an increased demand for metals and in the meantime our Institution is endeavouring to secure such appointments as become available, for its own members.

At a stage like the present, a large Benevolent Fund would be of inestimable value. We have recently initiated one out of the balance available from the Memorial Fund, but the amount is negligible in comparison with what is needed. This nucleus, coupled with the hard times we are experiencing, should, however, impress upon our minds that when opportunity offers we should do our best to build up a fund of useful size. It has not yet been considered whether some contributing scheme might not be established, but probably a purely voluntary scheme would best suit our case.

It is no doubt the wrong time to make a strong appeal on behalf of the permanent fund which has been established, but we should welcome at once even small contributions to a Relief Fund that would be immediately available for relief of any cases of distress brought to our notice, and I may say that we have reason to suspect that many deserving cases exist. Mining engineers, perhaps more than any other class, should do what they can to help one another.

The vocation of the mining engineer, which necessitates frequent and ofttimes protracted visits abroad, does not lend itself to the making of many close friendships outside his own profession, amongst those who would be ready to give assistance in times of distress. His intimate friends consist for the most part of brother engineers; often they are away in some distant part of the world when required, and rarely are they rich, for, contrary to general opinion, few mining engineers acquire wealth. We might all at least remember the Benevolent Fund of our Institution in our wills, even if only as residuary legatee.

My last remarks have a pessimistic flavour which I would like to remove by some words of encouragement. Unfortunately I am unable to see any marked signs of improvement in the mining industry, and though I possess the glass eyes to which Shakespeare refers in "King Lear," I cannot follow the advice there given, and "like a scurvy politician, seem to see the things thou do'st not." Fortunately, mining engineers are by nature hopeful, and we must keep on hoping, in which we may be encouraged if we keep calling to mind that it is almost everybody's experience that "most of their worst troubles never happened."

YTTRIUM.

By John Missenden, B.Sc.

Yttrium, which has been classed in the boron group together with lanthanum and scandium, distinctly belongs to the rare earth metals both by virtue of its discovery and source. It was due to Eckeberg, who obtained the rare earth called "yttria" by separating the substance previously examined by Gadolin, that its isolation from glucina has become a possibility; although in later years, investigation into the properties of yttria was responsible for the production of pure yttrium together with lanthanum, erbium, terbium, and didymium. Yttria itself, which may be regarded as the chief source of yttrium as its name suggests

actually accompanies terbia, erbia, thulia, dysprosia and holmia, the metals of the last three not being quite so well-known as to warrant any description. The proportions of these latter earths are so small compared with the yttria also found, that many authorities maintain that they are *contained* in yttria, an assertion that can scarcely hold good in the face of later results obtained by research.

The yttrium-containing minerals (which, it is obvious, contain the other metallic earths associated with yttria) are mostly of such a form as to appear like complex salts. The silicate minerals are the most important, the basic orthosilicate of iron, beryllium and yttrium (*gadolinite*) being more frequent than the others. There are also the tantalates, fluorides, niobates, phosphates and uranates, the mixtures being apparent from the following table:—

change is probably due to the energet action of light, the darkening process bein considerably retarded by preservation in box from which all light has been excluded.

Cleve [1] prepared pure yttrium by decon posing the double chloride of sodium an yttrium under the influence of an electr current, but a far more simple method is t fuse the ordinary yttrium chloride (*q.v* with an excess of sodium. The compound as examined, are as follows:—

Yttrium Oxide, Y_2O_3, may be obtained b adding the pure metal to boiling water, th oxide being thrown down in the form of white powder. It may be dissolved con pletely by the mineral acids, and burns wi an intense white light when exposed to flame.

With sulphur, two compounds, *yttriu sulphide*, Y_2S_3, and *yttrium sulphat* $Y_2(SO_4)_3.8H_2O$, are formed. The former

Silicates.	Niobates.	Tantalates.	Uranates.	Fluorides.
Keilhauite.		Keilhauite.		
Gadolinite.	Gadolinite.			
Cerite.				Cerite.
	Samarskite.	Samarskite.	Samarskite.	
	Euxenite.	Euxenite.	Euxenite.	

The quantities of yttrium (*q.v.*) obtained from two specimens are: Samarskite (mined in Raleigh, N. Carolina), 15.02 per cent., and Gadolinite (mined in Ytterby), 42.89 per cent.

As in many other cases of the more obscure elements, much diversity of opinion is held over the true atomic weight of yttrium. Hoeglund [1] states it to be 89.2, Bunsen's figure is 92, while Cleve fixed it at 88.4. A very careful analysis of the sulphate covering a long series of separate results, however, gives a mean of 88.1, and this determination is probably correct, previous errors being explained by the presence of minute quantities of other rare-earth metals.

The spectrum analysis of yttrium chloride is especially worthy of note. The projection shows two groups of distinct lines in the red sector that are somewhat near the sodium line but of slightly lower wave-length. Superficially, yttrium is an iron-grey powder when freshly obtained, and is apt to assume a darkish appearance when kept for an appreciable time. This phenomenon is not to be explained by the combination of the metal with oxygen, as the oxide is white, and precisely the same effect is observed when the metal is placed in vacuo. The

produced by raising yttrium chloride to high temperature and treating it with stream of sulphuretted hydrogen. It is yellow powder,[2] insoluble in water, bu soluble in mineral acids. The latter is cr stalline, and may be rendered anhydrous 120° C. An important characteristic of th salt is the fact that boiling water will yie up 47 per cent. of it, this figure being base upon 100 per cent. in solution at 15° C.

Yttrium carbonate, $Y_2(CO_3)_3.3H_2O$, soluble in water, and is a white powder wi a high density. It has not been greatly e amined.

There are three phosphates worthy notice:

Yttrium orthophosphate, $YPO_4.2H_2O$ *yttrium metaphosphate*, $Y(PO_3)_3$; an *yttrium pyrophosphate*, $2YHP_2O.7H_2O$ The first and last are soluble, and the la insoluble, in water. The similarity in com position between the anhydrous carbonat

[1] *Compt. Rend.* 1882, XCV., 1125.

[2] According to Popp, it is a *grey* powder, but I am inclined to think that he obtaine the pure metal, probably by the presence o too much moisture. The records of his ex amination of this grey powder are vague and might easily be results obtained throug

and the metaphosphate will be observed.

Yttrium chloride, YCl_3, is analagous in nearly every respect to the iodide, bromide and fluoride. *Yttrium fluoride* occurs in the mineral *yttrocerite* (Schorlemmer) mined in various parts of North America, and presents itself in a variety of colours, such as blue, violet, and brown. It is generally associated with the fluorides of calcium and cerite.

The reactions of the yttrium salts closely resemble the reactions of the zirconium salts, a description of which may be found in my paper published on June 9th (issue No. 3245) in the *Chemical News*.

CHEMICAL NOTICES FROM FOREIGN SOURCES

Reactions of Caustic Soda with Aluminium Salts. — *Edouard Grobet.* — The author has studied the effects of concentrated and dilute solutions of caustic soda upon various aluminium salts, using the method of electrical conductivities for the determination of the curves of reaction, and also the new volumetric method with the thermometer as indicator. When caustic soda is added to fairly dilute solutions of aluminium nitrate, the hydrate $Al(OH)_3$, the aluminate $Al(OONa)$ and the aluminate $Al(ONa)_3$ are formed in succession. With aluminium chloride, the sulphate and potash alum, the substances formed are $Al(OH)_3$, then the basic aluminate $Al(ONa)_3$, $Al(OH)_3$, and the aluminate $Al(ONa)_3$. With concentrated solutions of the nitrate, chloride or sulphate, the basic salt of formula AlX_3 $Al(OH)_3$, or $Al_2(Y_2)_3$. $2\ Al(OH)_3$, then the hydrate $Al(OH)_3$, the aluminate $Al(OONa)$, and finally the aluminate $Al(ONa)_3$ are successively formed. When concentrated solutions of potash alum are used, the compounds formed are first the basic salt $Al_2(SO_4)_3.2Al(OH)_3$, then the hydrate $Al(OH)_3$, the basic aluminate $Al(ONa)_3$.—(*Journal de Chimie* Physique, XIX., 1921, 329.)

Enesol.—*G. Rebière.*—The action of sodium methyl arsinate in solution upon oxymercuro-salicylic anhydride leads to the formation of a complex in which the molecules of the two substances are present in equal proportions. This complex contains 38.46 per cent. of "latent" mercury, and shows that a compound exists. The injectable solution for which the author suggested the name enesol contains 3 per cent. of this complex, *i.e.*, 11 milligrammes of latent mercury per cubic centimeter.—(*Journal de Pharmacie de Belgique*, IV., 1922, 453.)

Action of Thionyl Chloride upon the α Acid Alcohols.—*E. E. Blaise and Mlle. Montagne.*—When lactic and oxyisobutyric acids are treated with thionyl chloride, the chlorosulphite of the acid is not formed, but a compound of a new type, which the authors call an anhydrosulphite of acid alcohols. The two anhydrosulphites which the authors have prepared (lactic and oxyisobutyric) are easily decomposed when heated; at about 120° to 125° under atmospheric pressure they give off sulphurous anhydride, and a polylactide is formed, from which the original acid alcohol can be obtained. The anhydrosulphites are very sensitive to the action of water, and also react with alcohols to give the ether salts of the corresponding acid alcohols with liberation of SO_2, and the amides of the acid alcohols are obtained from them by the action of the arylamines. With phenyl hydrazine they give thionyl phenyl hydrazine with regeneration of the acid alcohol.—(*Comptes Rendus*, CLXXIV., 1922, 1553.)

Chlorhydrine of Mesityl Oxide and its Transformation into the Chlorhydrine of Tetramethyl Glycerine.—*M. Pasturcau and Henri Bernard.*—The chlorhydrine of mesityl oxide can easily be obtained by fixing hypochlorous acid at the double bond of the unsaturated acetone

$$\begin{matrix} CH_3 \diagdown \\ \quad C=CH-CO-CH_3 \\ CH_3 \diagup \end{matrix}$$

by the method of Baeyer, Lauch and Bamberger (action of boric acid upon calcium hypochlorite in solution). The product obtained after fractional distillation is a colourless oily liquid, something like camphor, which turns violet in the light. When a solution of it in anhydrous ether is added to methyl magnesium iodide an energetic reaction takes place which can be moderated by cooling if necessary. Thus a limpid liquid is obtained which can be decomposed by iced water in the usual way. When the ethereal liquid is fractionated in vacuo the portion which distils at 110° under 200 mm. consists of a viscous liquid which turns brown in the light, and from which crystals of the chlorhydrine of tetramethyl glycerine are deposited. — (*Comptes Rendus*, CLXXIV., 1922, 1555.)

NOTICES OF BOOKS.

Organic Compounds of Mercury, by FRANK C. WHITMORE, PH.D. Pp. 397. New York: Chemical Catalog Co., Inc., 1921. Price $4.50.

The American Chemical Society has arranged to publish a series of scientific and technological monographs on chemical subjects, and as one, Prof. Whitmore has written an able account of the extensive work done upon the organic mercury compounds, which, he states, is probably greater than that done upon the arsenicals, although it has hitherto received less publicity.

The author only briefly mentions the organic compounds containing the groups -O-Hg and -S-Hg, and has largely confined his attention to true organic mercurials in which the metal is directly attached to carbon. Nevertheless, a great variety of bodies are described with discrimination. Matter of minor importance receives mention in the bibliography, and although experimental details are omitted, enough is included to indicate the methods and to serve as a guide for preparations or for repetition of any particular work on the subject. The apparent ease and variety of methods for preparing these substances is very impressive and should stimulate further researches.

Some Organic mercury compounds have been used for the preparation of organic derivatives of phosphorus and arsenic. Others have found a limited application in medicine.

The word "mercuration" has been coined to indicate the introduction of the metal into an organic substance (*cf.* bromination, etc.).

There are several appendices, one of which is devoted to the analysis of these bodies and incorporates the author's valuable experiences in this direction. The method of his choice for the estimation of mercury, viz., amalgamation of the volatilised metal with an inverted gold crucible, can scarcely be adopted universally.

This well thought out book constitutes a valuable addition to the scanty literature of organo-metallic chemistry. J. G. F. D.

Industrial Hydrogen, by HUGH S. TAYLOR, D.Sc. Pp. 210. New York: Chemical Catalog Co., Inc., 1921. Price $3.50.

This technological monograph, also issued by the American Chemical Society, outlines the fundamental principles of the industrial production of hydrogen.

In the preface it is pointed out that modern chemical industry demands the intelligent co-operation of the chemist and engineer.

Attempts at elimination of the one or the other in the development of a new process, such as the large scale production of hydrogen, would be disastrous. But in treating this subject, neither chemist nor engineer can advantageously intrude upon the domain of the other. Prof. Taylor has therefore emphasised with care and lucidity the essential chemical details of hydrogen manufacture.

All the practical methods for its preparation are adequately described. They include the various ways for decomposing steam with iron; water by electrolysis, and by employing alkali metals, alloys and hydrides; aqueous alkalis with ferro-silicon, and aluminium. Methods for the production of hydrogen from water-gas by liquefaction, etc., and from hydrocarbons by thermal decomposition, and others of less importance are also described.

The chemical aspects of these processes are clearly and fully stated. This is particularly noticeable in the case of the methods using steam and iron. The special utility of some processes which are restricted to local or transport convenience or emergency needs is indicated by such a case as the hydrolith process, whereby it is possible to make 1,000 cu. ft. of the gas from about 65 lbs. of calcium hydride (with water).

Hydrogen for filling dirigibles and balloons is now extensively made by the interaction of ferro-silicon and aqueous alkalis, and this process may be developed considerably in the future.

The monograph deals with the manufacture of hydrogen in a general and comprehensive way, and will therefore be widely read and consulted by industrialists.

BOOKS RECEIVED.

Roger Bacon, The Father of Experimental Science and Mediæval Occultism. H. STANLEY REDGROVE. First Edition, 1920. Messrs. William Rider & Son, Ltd., 8, Paternoster Row, E.C.4. Price 1s. 6d. net. Pp. 63.

An Inorganic Chemistry. H. G. DENHAM, M.A., D.Sc., PH.D. Pp. VIII. + 683. First Edition, 1922. Messrs. Edward Arnold & Co., 41 & 43, Maddox Street, W. 12s. 6d. *net.*

Joseph Glanvill and Physical Research in the Seventeenth Century. H. STANLEY REDGROVE B.Sc. (LOND.), F.C.S., and I. M. L. REDGROVE. 1921. Messrs. William Rider & Son, Ltd., 8-11, Paternoster Row, E.C.4. 2s. *net.* Pp. 94.

NITROGEN FIXATION.

German and American synthetic ammonia plants. (Design and operation of apparatus used for synthesis of ammonia; description of different processes for removing the ammonia; comparison of costs of construction and production in America and Germany.) R. S. Tour.—Chemical and Metallurgical Engineering, New York, Vol. 26, March 1, 1922, pp. 411-15; March 8, 1922, pp. 463-5. 25c.

Contributions to the study of ammonia catalysts: a series of articles from the Fixed Nitrogen Research Laboratory. *(Description of apparatus for the small-scale testing of ammonia catalysts at atmospheric pressure.)* A. T. Larson, W. L. Newton, and W. Hawkins.—Chemical and Metallurgical Engineering, New York, Vol 26, March. 15, 1922, pp. 493-7. 25c —*(From Bulletin No.* 212 *of the Institute of Mining and Metallurgy).*

New Patents.

THIS list is specially compiled for *Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

17272—Bloxam, A. G.—Manufacture of azo-dyestuffs. June 22.

16927—Cassella & Co., Ltd.—Production of dyestuffs containing sulphur. June 19.

17381—Chemicsche Fabrik Weissenstein Ges.—Manufacture of hydrogen peroxide. June 23.

17159—Ellsworth, J. T.—Process of recovering zinc from *complex ores.* June 21.

17158—Munn, J. B.—Apparatus for chemically treating mineral oil products. June 19.

17261—Marks, E. C. R.—Zirconium alloys, and processes of making same. June 22.

Specifications Published This Week.

158882—Rosthorn, O. von.—Process for the manufacture of copper-alloys.

181058—Deutsche Gold and Silber-Scheide-Anstalt vorm. Roessler, and Liebnecht. Dr. O.—Manufacture of prussic acid.

181062—Cumberland Coal and Chemicals, Ltd., West, J. H., and Jaques, A.—Methods and apparatus for the production of hydrogen.

181198—Courtaulds, Ltd., and Lloyd, L. A.—Manufacture and production of compounds or mixtures of starch and sulphuric acid.

181247—Napp, H. R.—Process for the manufacture of cc.-isopropylallylbarbituric acid.

Abstract Published This Week.

Dyeing cellulose acetate.—Patent No. 179384.—A process of dyeing Acid, basic, mordant, substantive, vat, and sulphuretted dyes, has been devised by Burgess, Ledward & Co., Ltd., Wardly Mills, Walkden, and Harrison, W., Beechwood, Walkden Road, Worsley, both in Lancashire. The material is dyed with colloidal dye solutions *prepared by adding to a solution of dye* or leuco-compound a protective colloid (gelatine, casein, saponin, starch, &c.) and a precipitant (except metallic chlorides); preferably the precipitants are bodies which are themselves absorbed by the cellulose acetate. Suitable precipitates are:—For basic dyes, a weak alkali such as ammonia, a salt of an acid metallic oxide such as molybdates, tungstates, or stannates, or an organic compound *of acid character such as tannic acid or salts* of phenols, napthols, aromatic acids, hydroxacids, sulphonic acids, &c.; for acid or direct cotton dyes, a salt of an organic base such as aniline, benzidine, dianisidine, phenylenediamines, napthylamines, &c. Sulphur dyes are dissolved in sodium sulphide, hydro-sulphite, &c., and vat *dyes in sodium hydro-sulphite*, the same precipitants being used as in the case of direct dyes. Examples are given of dyeing triacetate silk in baths containing: Methylene blue, glue, and sodium stannate; magenta, saponin, and tannic acid; tsional navy blue R, sodium sulphide, glue, dianisidine, and acetic acid; ciba blue 2B or indigo, caustic soda, sodium hydrosulphite, glue, dianisidine, and acetic acid. Mixed goods containing *cotton may* be *dyed with sulphur or* vat dyes as described above, the cotton threads being subsequently dyed with direct dyes. The Provisional Specification describes also the use of salts of aluminium, barium, magnesium, &c., as precipitants for direct or acid dyes, and of oxidizing agents such as air, or metal salts as precipitants for vat or sulphur dyes; it also refers to the use of alizarin dyes using metallic salts or mordants or *organic bodies as precipitants.*

Messrs. Rayner & Co. will obtain printed copies of the published specifications, and forward on post *free for the official price of* 1s. each.

THE CHEMICAL NEWS,

VOL. CXXV., No. 3250

CHEMICALS REVIVE.

FREE TRAINING FOR OUR SILENT DEFENCE CORPS.

An all-round revival of the chemical trade is expected in the immediate future by Mr. Max Muspratt, of the United Alkali Company, Liverpool, who has just succeeded Sir John Brunner as chairman of the Association of British Chemical Manufacturers.

He points out in an interview that the heavy chemical industry "undoubtedly turned the corner at the beginning of the year, and the alkali portion of it, at any rate, has enjoyed real prosperity, shipping to all parts of the world. The acid side of the industry is slowly recovering from the most difficult period in its existence.

"At every turn the signs are promising. With much better reports from the textile industry, I expect that the dye industry will shortly get a real chance to show what it can do, and I am not afraid of its power of making good.

"There is no branch of the chemical industry in which more excellent work has been done than Fine Chemicals, and one of the greatest triumphs of the Association of *British Chemical Manufacturers* has been the manner in which the fine chemical makers have co-operated both with one another and with other branches of the chemical industry. They deserve every kind of support from the public at large because they are conducting at their works schools of practical chemistry which are of vital importance to the nation both in peace and war."

Sir Alfred Mond; Mr. Shortt, the Home Secretary; and Mr. Stanley Baldwin, President of the Board of Trade, were all guests at the annual dinner of the Association, which was held in private at the Holborn Restaurant, London.

INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

Journal and Proceedings, June, 1922.

LIVERPOOL AND NORTH-WESTERN COUNTIES.

At the 35th meeting of the Section, held at the Bear's Paw Restaurant on 6th April, a paper was read by the Hon. W. Hulme Lever on "The Value in Business of Scientific Training," Mr. H. J. Evans in the chair.

Mr. Lever said that some measure of scientific training was useful to the business man—not so much on account of the actual facts learned, as that it taught him to think scientifically.

Modern business was necessarily a large field employing a great many varieties of people. In modern commerce the chemist was employed as a chemist, the engineer as an engineer, the mineralogist as a mineralogist, and so on, but very often the ideal and most successful business combinations had been between a purely commercial man and a purely scientific man.

On the ideal board of directors there should be one scientific or technical brain, one legal brain, and one accountancy brain, with the addition of purely commercial brains.

Where did this vague, indescribable "something" called the commercial man come from? He had passed no special examinations to qualify him for his post. Frequently his sole graduation had been in the school of hard knocks, in the university of everyday life. Although it was becoming increasingly common to receive a University training, there would always be many in business who had not received this training; but, provided some form of training could be given, the question arose as to what form was the best. Undoubtedly any study followed systematically was good for the brain, but there was no training better than a scientific one. In his own case he had decided to take the Natural Science Tripos at Cambridge, and had never regretted his choice. No doubt he thought that to learn something of chemistry would be of direct use in the soap-making industry. It was not, however, for this reason that he found the training to be of use. Enough chemistry to enable a man to understand the principles of soap-making, in so far as they were required to be known by the commercial side of the business, could be learnt in a very short time. The training was of value because it induced a scientific mode of thinking.

The aim of study should not be the storing of facts *ad nauseam*, but the understanding of principles according to which these facts might be applied. In studying chemistry the aim was not to learn off by heart the list of atomic weights or to mem-

orise a host of formulæ and equations, which might readily be looked up in a text-book, but to understand what an equation was and to apply the principles underlying it.

After all, the general idea of the chemical equation was cropping up the world over. The balance sheet of a business was, in a sense, an equation, and the understanding of a chemical equation helped one to appreciate a business equation. Under the principle of the indestructibility of matter, capital put into a business must be accounted for in the same way as the chemical reagents put into a test tube, even to the formation of H_2O and the giving off of CO_2. There was a lot of H_2O and CO_2 about some balance sheets!

The principles learned in science were invaluable to the business man for the four following reasons, among others:—

1. Science seeks simplification.
2. Science seeks standardisation.
3. Science seeks truth.
4. Science teaches humility.

As to the first, scientific investigation explained more and more the phenomena of nature in terms of variations of simple units. The most complex living organism known was only a multiplication of cells, each with its essential protoplasm and nucleus, although the problem of what life really was remained unsolved. The modern physicist had shattered the older chemists' belief in the atom as the indivisible unit of matter by saying that all atoms were only different arrangements of electrons or negative charges of electricity. So must the successful business man ever search after simplicity. He must get down to simple units and arrange his problem in an orderly way. The clever business man could put his finger on the heart of a problem right away, because he knew that all the complications of business were only different arrangements of certain simple and essential principles, which, obeyed, led to success, or, ignored, led to failure.

With regard to the second reason, that science seeks standardisation—the essence of science was measurement, necessitating standards. No business man with a scientific training could rest content with the archaic and unwieldy units with which commerce dealt. The scientific mind craved for a universal metric system, both of weights and coinage, and it was interesting to note how many business houses turned shillings and pence into decimals of a pound for the internal working of their own system of accounts. The scientific mind also desired a linking up between the measurement of weight and the measurement of volume. Our unit of weight ought to be that of a definite volume of water.

Respecting the third point, that science sought truth—the scientific man in his investigations rarely craved for anything else; and the same should be said of the sound business man. Each should be equally capable of discarding all points and opinions which did not lead towards this goal. The whole history of science was a pilgrimage in search of truth.

At the fourth point, that science taught humility, some might be inclined to smile; but regarded dispassionately and seriously, it would be found to be true. The non-scientific mind was staggered at the accomplishments of science. The scientific man overlooked the accomplishments in face of the mysteries yet unsolved. The unknown was not a definite something which would one day be entirely discovered and turned into the known. It had been truly said that knowledge was like a circle ever widening as it grew, and the more it grew, the greater—not the less—became its area in contact with the unknown.

The business man should take a leaf from the book of the scientific man and realise that the present triumphs of commerce did not represent the last word. The business man who sat down content with himself and his business only sat down to watch the business go back and not forward. The scientific world never rested content; the more it probed into the unseen mysteries the more it realised how little was known and how much there was to know.

We scatter the mists that enclose us,
  Till the seas are ours and the lands,
Till the quivering æther knows us,
  And carries our quick commands.
From the blaze of the sun's bright glory
  We sift each ray of light,
We steal from the stars their story
  Across the dark spaces of night.
But beyond the bright searchlights of science,
  Out of sight of the windows of sense,
Old riddles still bid us defiance
  Old questions of Why and of Whence.
There fail all sure means of trial,
  There end all the pathways we've trod,
Where man, by belief or denial
  Is weaving the purpose of God.

In the discussion, Dr. Brislee said that he much appreciated the idea of having men with scientific training on every board of directors in order to establish a bond of sympathy between the technologists and the financiers. While it was awkward for the technical man to be bothered with questions of cost, he, nevertheless, should have a definite idea of the value of labour and materials, and work hand in hand with his financial confrères. Separate branches of a concern working in watertight compartments hindered progress. He remembered, for instance, the case of a new managing director of a large locomotive works, who, at the outset, stated he had not come to make locomotives, but to make money. An unsympathetic attitude made things very difficult for the researcher, who might easily be presented with difficult problems on which he might spend a large amount of diligent and intelligent work with little practical result. A still more disappointing result followed when he was directed on a wrong course and asked to get out certain desired information, perhaps involving a deal of labour, when he knew from the outset that it would not lead to the end desired. The researcher thus appeared to be doing a large amount of unproductive work, and, indeed, was often required to carry out an investigation which was not immediately realisable as a financial asset. It was becoming increasingly incumbent upon industrial chemists to undertake pure research, because they could not predict when a discovery would become of technical importance, especially when the theoretical groundwork had not been cleared. The non-technical mind could not always appreciate the fact that lines of research, projected on the idea of definite direction of investigation leading to a definite result, were not always practicable. The experience of Research Boards all over the country amply proved this. He much appreciated Mr. Lever's view that some knowledge of science on a board of directors would establish a link of sympathy, and he was confident that it would spur the chemist on to better work.

Mr. Stocks said they were very much indebted to Mr. Hulme Lever for his interesting and instructive address, and hoped that they would have the privilege of hearing him on future occasions. With regard to the relationship of science to industry, there were many ancient industries, such as dyeing and leather manufacture, which, although depending on scientific principles, had grown up without scientific control, simply by those in charge trying various experiments, rejecting the failures, and assimilating the useful ones. This method was a tedious one. Although matters were now much altered, chemists were not yet appreciated at their true value. There were many works which did not yet employ chemists, and often the chemist was not called in until something awkward happened which he had to put right. A chemist, if he was any good at all, would learn his business, and would be able to teach workpeople how to do things properly in order to avoid mistakes which it was necessary to rectify. He hoped to live to see the time when a chemist's starting salary would be £1,000 a year. In a large works, where specialisation was necessary, chemists were grouped into analytical chemists, research chemists, and works or process chemists; but in a small works the chemist had to be all these, and perhaps in his spare time help in other ways, even with book-keeping and despatching goods. In some works the chemist was kept too much in the laboratory and not allowed to go into the works, where he was regarded as a bit of a nuisance, as he was always nosing into things; but he advised them to get out into the works as much as possible and learn as much as possible. He was interested in Mr. Lever's ideal board of directors, especially that it should contain at least one scientic man, and he hoped that even more than one would be appointed to each board. Although often regarded as having little business ability, scientfiic men were in many cases more businesslike than business men, and there was no reason why scientific attainments and business ability should not go together. One attribute of the scientific man, that of humility, mentioned by Mr. Lever, was illustrated by a quotation from Bishop Spratt referred to in the "History of the Institute of Chemistry," which he read.

"The chymists lay it down, as a necessary Qualification of their happy Man, to whom God will reveal their ador'd Elixir, that he must be rather innocent, and virtuous, than knowing. And if I were to form the Character of a true Philosopher, I would sure to make that the Foundation: Not that I believe, God will bestow any extraordinary Light in Nature, on such Men more than others; but upon a bare rational Account: For certainly, such Men, whose Minds are so soft, so yielding, so complying, so large, are in a far better Way, than

the bold and haughty Asserters: they will pass by nothing, by which they may learn; they will be always ready to receive, and communicate observations; they will not contemn the Fruits of others Diligence; they will rejoice to see Mankind benefited, whether it be by themselves or others."

Among the wonderful things which the chemist in the works could now do, according to a report in the *Echo* recently, was the manufacture of nitroglycerine from vegetables. At first sight this would appear similar to making T.N.T. from turnips, but the journalist had seized upon the least interesting part of his communication for his title, the real object being the extraction of palm oil.

Mr. Knowles thanked Mr. Lever for his very interesting lecture, and wished to place before the meeting his own views of how the chemist fared in Germany previous to the war. There was no doubt that Germany built up her great chemical industry, and particularly her coal tar colour industry, by getting the best chemical brains possible into the business. There were always chemists on their boards of directors, and frequently a chemist in charge of process work, besides the chemists required for control of materials bought and the products sold, to say nothing of chemists on research. One thing, however, which impressed him whilst in Germany was that a man was given a post because he was a suitable man from the point of view of his capability, and not because he just happened to be the son of a man who already had a good post in the firm; and there was no doubt that this thorough way of putting business first helped a great deal towards their ultimate success. Another way in which Germany pushed her coal tar colour industry was by the employment of chemists as technical travellers. Inventors were better looked after in Germany, particularly from the financial aspect, as they had a system of banking, e.g., a "Gewerbe Bank," whose business was to lend money on new inventions after they had been thoroughly examined by expert technical men.

Dr. Clarke suggested that the Institute should arrange for Mr. Lever to repeat his address before commercial leaders of industry, because he was able to explain the value of a scientific training in a manner that the specialised man of science certainly could not. In many industries there was still a lack of sympathy between the commercial man and the chemist. This, in the speaker's opinion, was due to two causes: (*a*) The belief of the commercial man that the chemist was the cure for all ills, and that any difficulty could be turned over to a research department and become solved; the commercial man showed disappointment when a solution was not forthcoming; but he should realise that research by qualified men was only the *best* means of tackling a difficulty and not a sure means; (*b*) the technical man took the attitude that the commercial man would not understand a technical problem, even if it was explained to him, and hence it was waste of time to attempt it. The commercial man was thus left in mid-air on many technical matters, a thing he naturally resented. The technical man consequently should take considerable pains to keep the commercial man in touch with technical matters, simplifying his explanations as much as possible. In the opinion of the speaker, the chemist was too much inclined to sit down and wonder why his services were not appreciated more, instead of considering whether he himself was not mainly contributing to his non-recognition. The chemist generally was not very adaptable. He frequently showed little tact in dealing with commercial men, as mentioned before, and frequently no tact at all in dealing with plant managers. Plant managers generally had accumulated a wide store of knowledge by exercising powers of observation without any underlying scientific training. They were people who demanded considerable respect from chemists, and not the contempt that they frequently got. If the chemist considered such points as these he would contribute to the better recognition of science in industry.

Mr. Moore said that in most large businesses there were many grades of workers who had different duties. A scientific training would be of benefit to all, but it was of particular value to those who occupied the higher positions. The men who occupied these high positions, besides requiring a thorough knowledge of the business, had to be clear thinkers. It was necessary for them to be of sound judgment, to be able to estimate the value of evidence, and to be able rapidly to select the best line of action out of several possible ones. They should be able to sift the essential elements out of a mass of detail.

They should be men of broad outlook, able and willing, when necessary, to develop the business on new lines and to adapt themselves to new methods and new conditions.

In the course of a scientific training, a student was constantly considering facts and their inter-relations. In his experimental work he was frequently using the facts he knew, in order to produce results which to him were new. If his use of the facts was not proper, or if his thinking lacked clearness, or if his judgment was not sound, then the experiments would be partly or wholly unsuccessful. Thus the clearness of his thinking and the soundness of his judgment were being continually exercised and tested in a practical manner. Many experimental results could be obtained in a variety of ways, and hence the student had to make a choice of one of several methods. He had to consider such factors as time, cost, the apparatus and facilities at his disposal, the purity and quantity of the product, etc. As he advanced in his work, he learned of some of the more important researches that were being conducted, and began to appreciate that knowledge was continually advancing and expanding. His outlook became modified, and he realised that it would be necessary for him, as knowledge progressed, to discard some of the facts and processes which he formerly accepted and used, and in their place to substitute new facts and new methods. In the last year or two of his college training, he would probably have opportunities for taking part personally in some research work, and thus would have the very valuable opportunity of making some personal contribution to the growth of knewledge.

Thus a man who received a scientific training was continually exercising and developing those qualities of mind which were of such importance in business. Not only was he exercising and developing them, but he was constantly using them to produce definite practical results. Hence a scientific training as a preparation for business was very valuable.

Mr. Gabriel Jones, while disclaiming any first-hand knowledge of chemical industry, thought a very important point mentioned by Mr. Hulme Lever was his ideal board of directors, and he believed that probably many industrial concerns had come to grief through the lack of technical brains on the board; it was often unsatisfactory for a number of purely business men engaged in chemical industry to decide upon a course of action and then to leave their chemists to work out the problem. Chemists engaged in industry had opportunities of meeting their employers on equal terms in such bodies as the Society of Chemical Industry, and he recommended membership of that Society to chemists for that reason, and also for the chance it gave them of helping their purely business associates with their scientific knowledge. Mr. Hulme Lever had likened a balance sheet to a chemical equation, but he (the speaker) thought that there was a difference between the two that was very obvious. Whilst in a chemical equation, one expected the same quantity of matter to result from the reaction as was originally put in, he supposed that a balance sheet in which the "matter" produced was not greater than that supplied would be regarded as unsatisfactory. He thought also, from opinions he had heard expressed, that more co-operation between chemical and engineering staffs in manufacturing concerns was desirable; they were too prone to work in watertight compartments.

Mr. Inman suggested that a report of the meeting should be sent to various chemical journals, with a view to advertising the existence of the Institute, and the proceedings of the Local Section, because the lecturer had stated the scientifically trained man's case so aptly.

The meeting closed with a cordial vote of thanks to Mr. Hulme Lever for his paper.

GEOLOGICAL SOCIETY OF LONDON

June 28th, 1922.

Prof. A. C. Seward, F.R.S., President, and afterwards Mr. R. D. Oldham, F.R.S., Vice-President, in the chair.

The following communications were read:—

1. *The Petrology of the Metamorphosed Rocks of the Start Area (South Devon)*, by Cecil Edgar Tilley, B.Sc., A.I.C., F.G.S.

2. *The Glaciation of the Counties of Antrim, Down, and parts of Armagh, Londonderry, Tyrone, Monaghan, and Louth in Ireland*, by Major Arthur Richard Dwerryhouse, T.D., D.Sc., M.R.I.A., F.G.S.

The next meeting of the Society will be held on Wednesday, November 8th, 1922.

ROYAL SCHOOL OF MINES—FRECHEVILLE RESEARCH FELLOWSHIPS.

The Imperial College of Science and Technology, with which the Royal School of Mines is incorporated, is offering two *Research Scholarships of £300 a year each, tenable for one year and possibly renewable for a second year*, to aid in carrying out any investigation or research connected with Mining, Mining Geology, Metallurgy, or the Technology of Oil, which, in the *opinion of the Selection Committee, is of* sufficient use or promise. Applicants, who may be Associates of the Royal School of Mines, or others, and preferably men with some practical experience, should apply in writing to the Secretary of the College (*from whom further particulars may be obtained*) before September 1st, 1922, giving the nature of the proposed investigation, qualifications for the work, and references. It is anticipated that the Committee will make the awards by the end of November, so that the Fellowships and work may begin on January 1st, 1923. Holders will be expected to devote their whole time to the work, which may be conducted at the Imperial College, or in special circumstances elsewhere, at the discretion of the Committee.

THE DECOMPOSITION OF IODOFORM IN SOLUTIONS BY MEANS OF RADIANT ENERGY.

By E. H. BUTLER.

Many phenomena are manifestations of wave motion. The wave motion differs in the several cases, so that under certain conditions we have sound waves, under others light waves, and again we might get those conditions which give rise to those waves which are more familiarly known as the X-rays.

In any case, wave motion is possessed of energy. Sound waves may cause the shattering of glass at a distance of many miles from the seat of the disturbance, while the whole science of photography owes its name and its existence to the effects produced in specially prepared films by the wave motion which constitutes light.

If wave motion is brought from a high to energy may appear as heat or as chemical energy, or both. It is quite possible that it appears in other ways, but the outstanding fact is that transformation does take place. In a system reacting chemically, this transformation may assist that reaction or retard the reaction, though such cases of retardation are uncommon. In the case of light energy, the rate of a reaction is usually increased, the light acting, in a sense, as a catalyst. Such actions are called photo-catalytic reactions.

The combination of chlorine and hydrogen has long been known to be sensitive to the action of sunlight. It is a reaction that has been studied very considerably by such workers as Bunsen and Roscoe, and more recently by Bodenstein and J. J. Thomson. It is very probable that the chlorine molecules are set in a state of more rapid vibration by a resonance effect, and so made more capable of chemical action.

Decomposition of substances is more common than synthesis in actions using light as radiant energy. The amount of action depends on the amount of light absorbed and also on the amount of that light which has been transformed into chemical energy. Thus, in solutions, the solvent exerts a considerable influence.

The decomposition of iodoform in various solvents was studied. This decomposition has been studied by Plotnikow (*Zeitsch. Phys. Chem.*, 1910, LXXV., 337), who found that the decomposition was mono molecular. This is somewhat surprising since energy is constantly being supplied to the system, and also because the light intensity must vary at the successive layers of the solution. The reason for this behaviour is not known.

The iodoform solutions were in each case N/20, and the source of light energy, a 100 candle-power lamp of the half-watt type placed at such a distance that heating effects were minimised. The solutions were placed in shallow, open dishes. The solvents used being (a) Alcohol (ethyl), (b) Benzene, and (c) Carbon tetra-chloride. The iodine liberated was estimated using sodium thiosulphate solution, N/100.

(a) *Alcohol as solvent.*

No iodine liberated after 40 minutes' exposure.

Temperature, 15° C. Value of 'a' = 23 ccms.

Time (mins.).	Thiosulphate used. per 5 ccms.	Values of $K = \frac{2.30}{t} \log \frac{a}{(a-x)}$
5	0.40 ccms.	0.00355
10	1.25 ,,	0.00557
15	1.80 ,,	0.00543
20	2.30 ,,	0.00527
25	2.65 ,,	0.00428
30	3.05 ,,	0.00536
35	3.25 ,,	0.00431
42	4.10 ,,	0.00467
47	4.60 ,,	0.00474
57	6.05 ,,	0.00534

(c) *Carbon tetra-chloride as the solvent.*

Temperature, 15° C. Value of 'a' = 23 ccms.

Time in mins.	Thiosulphate used per 5 ccms.	Values of $K = \frac{2.3}{t} \log \frac{a}{(a-x)}$
5 mins.	0.50 ccms.	0.00437
10 ,,	0.80 ,,	0.00354
15 ,,	2.20 ,,	0.00570
20 ,,	3.55 ,,	0.00835
25 ,,	4.40 ,,	0.00834
30 ,,	5.10 ,,	0.00832
35 ,,	5.70 ,,	0.00812
40 ,,	7.10 ,,	0.00917
47 ,,	7.70 ,,	0.00856
52 ,,	8.30 ,,	0.00852

Decomposition in the case of (b) and (c) did not cease on the withdrawal of the light. The decomposition continued in the case of the carbon tetra-chloride solution for several hours in the dark after exposure to the light, while in the case of benzene as the solvent, decomposition stopped sooner.

Transference of some of the exposed solutions to freshly made and unexposed solutions did not promote decomposition in those solutions. This, however, happens if the source of light energy is more powerful than that employed as above.

The decomposition of iodoform in the above solvents is accelerated by passing a stream of oxygen or air through the solutions. The process is one of oxidation in which formic acid is probably produced though in the above experiments this was not detected owing to the small amount [illegible]

If chloroform is used as the solvent, decomposition is more rapid, but it must be noted that chloroform is itself decomposed in the presence of light, while carbon tetrachloride is not affected.

NOTES FROM FOREIGN SOURCES.

RECENT ATTEMPTS TO SEPARATE ISOTOPES.*

By A. Pinkus.

Ever since the first researches in radiochemistry were performed, and long before K. Fajans and F. Soddy had clearly stated the problem of isotopy, this disconcerting characteristic of certain radioactive elements had revealed itself—the absolute identity of the most diverse chemical and physical properties in spite of different atomic weights and a definite power of disintegration. The phenomenon was at first regarded as exceptional and limited to the radioactive elements, but was soon perceived to have a much more extended significance. Thus, in 1913, J. J. Thomson's researches on the spectrum of neon and the discovery in the following year of the varieties of lead of different combining weights proved the complex nature of these two inactive elements. Thomson's method of analysis, perfected in 1919 by F. W. Aston, so as to give the masses of the carriers of charges correct to one thousandth, has enabled this result to be confirmed as regards neon and to be extended to nine other ordinary elements—chlorine, argon, mercury, krypton, xenon, boron, silicon, bromine and nickel. Thus isotopism appears to be a normal phenomenon, exhibited by many ordinary chemical elements. This result acquires a special importance in view of the fact that all the mass spectra, with the exception of that of hydrogen, give whole number atomic weights both for the simple elements and for the constituents of elements recognised as complex. The following table gives Aston's latest results for complex elements:—

* Abridged from the *Journal de Chimie Physique*. XIX., 4, 336.

Element.	Atomic Weight.	Number of Isotopes.	Atomic Weights from mass spectra.
Boron	10.90	2	11;10
Neon	20.2	2	20;22;(21)
Silicon	28.3	2	28;29;(30)
Chlorine ...	35.46	2	37;37 (39)
Argon	39.9	2	40;36
Nickel	58.68	2	58;60
Bromine ...	79.92	2	79;81
Krypton ...	82.92	6	84;86;82; 80;78
Xenon	130.2	5 (7)	129;132;131; 134;136; (128;130)
Mercury ...	200.6	(6)	(197-200); 202;204.

(The numbers in brackets are not regarded by Aston as definitely established).

As the domain of isotopism enlarges, the question of the separation of isotopes acquires increasing importance, especially for inactive elements such as chlorine and mercury for example, the complex character of which has been revealed only by the positive ray method, and which seem to exist in nature only in mixtures which are always identical. The electromagnetic method, moreover, only leads to indeterminable quantities of simple separated atoms, and hence cannot be used in the comparative study of their properties. It does not appear to be of very general application and is very unreliable, at any rate as employed at present, in the case of the many elements which have a low vapour tension and which do not yield stable volatile compounds. In the case of these elements, attempts at direct fractionation remain the only means at present of investigating isotopism.

Any method of fractionating mixed elements must evidently be based upon the sufficiently accentuated non-identity of a given property of the isotopes. The first to be studied were naturally the chemical and electrochemical properties which, according to the older views, could not be the same for two elements of different atomic weights. All attempts hitherto made in this direction have always been a complete failure, and it is just this failure which has largely contributed to the development of the theory of isotopism. The failure led to the conclusion that only methods depending upon the atomic mass could lead to positive results. But in the light of certain modern theories this conclusion has largely lost its restrictive value. Actually in Rutherford and Bohr's model of the atom the mass of the nucleus would certainly have some influence, however slight, upon the configuration and frequencies of the outer electrons, so that even the properties, the origin of which is in the superficial layer of the atom, would show certain differences in two isotopic elements. At the present moment, our knowledge is not sufficient to enable us to foretell with certainty the magnitude of these differences. Hence a method of separation which is applicable to ordinary elements cannot *a priori* be regarded as absolutely useless in the case of isotopic elements. Experience has to decide in each special case.

Experience has already decided in the negative in the case of fractionation, based upon a difference of chemical affinity, electrochemical properties, solubility, vapour tension in the solid or liquid state. All these methods appear to be definitely abandoned to-day. On the other hand, special methods have been tried or suggested, and some of them have finally given, especially during the last two years, positive results which seem to be definitely established.

The attempts to separate isotopes, the results of which have been published in 1920 and 1921, have depended upon the three following methods:—

I. Action of Centrifugal Force.

II. Diffusion in the Gaseous State.

III. Evaporation under reduced pressure followed by an immediate condensation of the vapourised molecules.

The first of these methods is based upon the proportionality between the densities and the atomic weights of the isotopes. The efficiency of the method was discussed in 1919 by F. A. Lindemann and F. W. Aston, according to whom centrifugation of liquefied neon (regarded as a mixture of two isotopes of atomic weight 20 and 22), or of fused lead (regarded as a mixture of Pb U and Pb Th of atomic weight 206 and 208) performed in suitable [illegible]

with a peripheric velocity of 10 cm. per second would lead to differences of the order of 0.5 per cent. between the densities of the portion nearest to and that furthest from the centre of rotation. The method was applied in 1920 by J. Joly and J. H. J. Poole to the separation of Pb Th and Pb U, the atomic weights and densities of which show a difference of about 1 per cent. The experiment was carried out with ordinary fused lead contained in steel tubes heated electrically placed upon a centrifuge turning 150 times per second. The tubes were 6 cm. long, the distance between the centre of rotation and the nearest extremity of the tube was 4 cm., which corresponds to a peripheric velocity of about 9.4×10 cm. per second. After an hour's centrifugation, the metal was rolled into spheres, as homogeneous in structure as possible, and the densities of the specimens thus obtained were compared by successive weighings in air and methyl iodide. The determinations of the density were made to 0.003 per cent. about. The results of five experiments showed that the sphere coming from the lower end of the tube was in three cases denser than that coming from the upper end (differences 0.05, 0.006, 0.01 per cent.), in one case it was less dense (difference 0.003 per cent.), and in one case the density was the same. These results indicate that no separation has been proved. The calculations of Lindemann and Aston referred to these experimental conditions would only foretell a difference of 0.005 per cent. between the two spheres. In spite of these negative results it is probable that the centrifugation method will not be abandoned. According to J. H. J. Poole, it will only be necessary to increase the velocity of rotation about seven times with the same experimental arrangement in order to obtain clearly detectable separations. In the case of mercury, for example, considered as a mixture of isotopes of atomic weight 200 and 204, in these conditions the differences of density obtained would be 0.15 per cent., and the calculated results are even more favourable in the case of neon.

(To be Continued.)

PHOSPHORUS IN CALIFORNIAN PETROLEUM.

CHASE PALMER.

Operators in oil fields already realise the composition of underground waters, but the general impression seems to be that nothing more is needed than a statement of the items employed to determine the fitness of a water for use in a steam boiler. Consideration of the composition of oil field waters is confined almost wholly to the major constituents of such soluble minerals as common salt, glauber's salt, gypsum and soda. Little evidence concerning the minor constituents of oil field solutions has been sought, and it is not surprising, therefore, that in the waters of the oil measures of California phosphates have escaped observation. If the prevailing opinion is correct, namely, that phosphates in all waters are derived only from the mineral, calcium phosphate, dissolved with difficulty out of the adjacent rocks and sands, then, of course, the minute quantity of phosphate possible in an oil field solution can have little significance and may well be disregarded. If, on the other hand, phosphorus can be found in the oil with which these subterranean solutions have been in contact, then the importance of knowing the phosphate content of an oil field water is apparent.

On a single section of the Sunset district, California, five well waters presumably from the same oil sands were found to contain phosphates in quantities ranging from 0.4 to 2.6 parts of phosphates (PO_4) in one million parts of solution. Although all of these solutions are primarily brines, some of them are modified chiefly by interaction with oil while others are mixtures containing also waters intruding from outside the oil measures. The persistence of phosphate in these waters suggested the possibility that phosphorus might also be present in the oil of that locality. Consequently a heavp oil from the same section that produces the phosphate solutions was closely examined and found to contain phosphorus to the amount of one one-hundredth of one per cent. of its weight. Another heavy oil drawn from a shallow well in the Kern River oil field also showed a phosphorus content of one one-hundredth of one per cent. This well has been producing oil for several years.

NITROGEN COMPOUNDS IN CALIFORNIAN PETROLEUM.

Phosphorus and nitrogen in the properties of their compounds resemble each

pounds constitute a large part of a Californian crude oil, consideration of the chemical nature of these nitrogen compounds may throw light on the source of phosphates in oil field solutions.

Californian petroleums consist essentially of three very different classes of organic compounds, namely, hydrocarbons, hydrocarbons with sulphur, and hydrocarbons with nitrogen. The nitrogenous hydrocarbons are usually called organic nitrogen bases. Members of all of these classes are oxidizable, but their oily nature shields them from direct attack of inorganic oxidants mobile in the waters or fixed in the rocks. The organic nitrogen bases, however, form soluble salts with strong acids so that considerable quantities of these nitrogen bases are undoubtedly dissolved by the corrosive waters of the oil measures and the resulting solutions of organic nitrogen salts, necessarily in a state of high dilution, can offer little resistance to the attacks of oxidants. In 1899 Mabery[1] prepared a long series of organic nitrogen bases by digesting an oil from Santa Paula, California. More recently Mabery and Wesson[2] have shown that under certain conditions an inorganic oxidant, like potassium permanganate, oxidizes these organic nitrogen bases to organic nitrogen acids, while under other conditions ammonia is formed. Appreciable amounts of ammoniacal compounds and of organic nitrogen acids are therefore to be expected in a water closely associated with a Californian oil. The organic acids obtained by Mabery are derivatives of pyridine, an important constituent of bone oil produced by distilling the bones of vertebrates.

Nitrogen Compounds and Phosphates in Oil Field Waters.

Waters from the oil measures of the Sunset, Midway, Kern River and Coalinga fields were found to contain nitrogen compounds in the forms of free ammonium salts and of organic nitrogen acids, often in large amounts. These products conform to the products which Mabery and Wesson obtained by oxidizing the organic nitrogen bases extracted from the oil from Santa Paula. Nitrogen compounds were not looked for in every water in which phosphate was known to be present, but whenever nitrogen compounds were sought in phosphate waters they were found.

A well that has been producing both oil and water in the Sunset district furnishes strong evidence that the oil has suffered powerful mineral oxidation. The water solution brought up with the oil and primarily a brine, itself somewhat modified by the mineral material which it has dissolved out of the rocks, was found also to contain free ammoniacal compounds as well as organic nitrogen compounds in amounts corresponding to 335 parts of ammonium chloride and 635 parts of organic nitrogen acids in one million parts of the solution. This water also contained 2.7 parts of phosphate per million.

The presence of phosphorus in Californian oils and the usual association of phosphates with the soluble oxidation products of organic nitrogen bases in the waters of the oil measures point to the oil as the source of these phosphates.

Underground Oxidation.

When nitrogenous organic matter decays under atmospheric conditions nitrites and nitrates are among the final oxidation products and surface waters polluted by decomposing organic matter often contain nitrogen in all the four forms that have been mentioned. It is a striking fact that these aqueous solutions brought up by the wells, solutions which have reacted with the oils underground and are charged with ammoniacal salts and organic nitrogen acids, have failed to show the presence of nitrates and nitrites. The organic nitrogen bases of the petroleum, therefore, normally suffer only partial oxidation underground, the limit of oxidation coinciding with the limit which Mabery and Wesson reached by oxidizing the organic nitrogen bases of Santa Paula oil with potassium permanganate.

Manganese dioxide and other oxides of manganese are freely distributed in the oil regions of California. With corrosive brines they would form soluble manganous chloride and halogen which by a cycle of well-known reactions easily produces active oxygen from the solution. Oil field solutions usually contain manganous chloride formed

[1] *Mabery, C. F., Journ. Soc. Chem. Ind., vol.,* 19, 505 (1900-.

[2] *Mabery, C. F., and Wesson, L. G., "Constitution of the Organic Nitrogen Bases of California Petroleum." Amer.*

oxide by the organic nitrogen salts dissolved from the oil. Moreover, higher oxides of manganese seem to be easily accessible because the muds brought up with the oil and water often contain the dark oxides of manganese.

VENTURA EMULSION.

To learn whether the dual occurrence of phosphorus in oils and waters is peculiar to the oil measures of San Joaquin Valley examination was made of an emulsion[1] from the Ventura oil field close to the Pacific coast and about fourteen miles distant from Santa Paula. The permanent emulsion still contained 53 per cent. of suspended water and about 0.005 per cent. of mineral material that could not be removed. Manganese was found in this residue which had been held up in the emulsion.

The oil in this emulsion was found to contain phosphorus to the amount of 0.008 per cent. of its weight.

The water set free from the emulsion is a brine containing free ammonium salts and organic nitrogen compounds in abundance. A very small quantity of soluble manganous salt is also present. The water was perfectly free from nitrites and nitrates, but it contained as much as 5.2 parts of phosphate per million. The activi-

Supplied by Mr. B. H. van der Linden of the Shell Oil Company.

ties in the Ventura oil measures are evidently like the activities in the oil measures of San Joaquin Valley.

The conclusions reached in this investigation are briefly stated in the following summary.

SUMMARY.

Californian heavy oils containing nitrogen bases have been found also to contain phosphorus.

These nitrogen compounds and phosphorus compounds may be oxidized by minerals through the agency of underground water solutions and without the help of atmospheric oxygen.

The association of phosphorus compounds with nitrogen compounds in oils of different fields is another link in the chain of evidence that Californian petroleum is of animal origin.

Eaton Laboratories, San Francisco.

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[1] *Supplied by Mr. B. H. van der Linden of the Shell Oil Company.*

[Reprinted from ECONOMIC GEOLOGY, Vol. XVII, No. 2, March-April, 1922.]

NOTICES OF BOOKS.

(1) *Roger Bacon, the Father of Experimental Science,* by H. STANLEY REDGROVE, B.Sc., F.C.S. Pp. 63 + 1 plate. Price 1s. 6d.

(2) *Joseph Glanvill and Physical Research in the Seventeenth Century,* by H. S. REDGROVE, B.Sc., F.C.S., and I. M. L. REDGROVE. Pp. 94 + 1 plate. Price 2s.

London: Wm. Rider & Son, Ltd., 8-11, Paternoster Row, E.C.

(1) It was pointed out in the review of Mr. Redgrove's *Alchemy: Ancient and Modern,* which recently appeared in *The Chemical News,* that the lives of many of the alchemists were very interesting, and therefore this life of Roger Bacon by an author so admirably equipped to deal therewith is very welcome.

Roger Bacon was an original thinker, and in his ingenious speculations anticipated many modern discoveries, such as the telescope, microscope, etc. As a result, he has been erroneously credited with some of these discoveries, and a recently discovered MS. in cypher would appear to support the attribution. The authenticity of this MS. is very questionable, and Mr. Redgrove has done well in ignoring it and basing his estimate of Roger Bacon upon his undoubtedly authentic works. Bacon did make one discovery in experimental science, namely, that of gunpowder, but his claim to greatness does not rest on this, or on his ingenious speculations, but upon his remarkable grasp of the true nature of the method of science as a combination of experiment and mathematics.

The life of Roger Bacon, too, is interesting as an example of the contest between the spirit of science and that of tradition and authority. Mr. Redgrove has chosen an admirable theme, and has dealt with it in a masterly and most interesting manner.

(2) The work on Glanvill may not, perhaps, make so strong an appeal to chemists as that on Bacon, but it deals with the same theme of the conflict of science with the powers arrayed against it in times gone by. Joseph Glanvill was one of the earliest Fellows of the Royal Society. In those days the Society was looked upon with disfavour by those who were pledged to traditional beliefs. Glanvill rendered the Society and the cause of Science great service by his books and writings in defence of the new experimental philosophy

Amongst his friends was the Hon. Robert Boyle, who took a great interest in his investigations in what we should now call psychic phenomena. In these investigations, as elsewhere, Glanvill exhibited the spirit of scientific enquiry, and the authors are justified in claiming him as the pioneer of Psychical Research. Glanvill's works deserve to be far better known, and we are indebted to Mr. and Mrs. Redgrove for this admirable account of them and their author.

The work on Bacon contains a reproduction of a photograph of Mr. Hope-Pinker's fine statue of Bacon, at Oxford, and that on Glanvill is illustrated with a reproduction of Faithhorne's engraved portrait of Glanvill. J. G. F. D.

An Inorganic Chemistry, by H. G. DENHAM, M.A., D.Sc., PH.D. Pp. VIII. + 684. London: Edward Arnold & Co., 1922. Price 12s. 6d.

The number of textbooks on Inorganic Chemistry increases every year. It is doubtful whether many of the newer ones possess such outstanding merit, beyond containing more recent work, for them to displace extensively the earlier ones.

The necessity for correlation and classification of observations and facts is pointed out. These can be most surely impressed upon beginners with the aid of the Natural Laws of Science and carefully examined hypotheses.

In this book, the arrangement of the subject is based upon the Periodic Classification of the Elements. The groups of elements are considered upon this plan after a study of the Halogens.

The basic, amphoteric and acidic properties of oxides are emphasised in a manner calculated to produce a correct impression of the chemical properties of various elements.

The Ionic Theory is not introduced until late in the book. This has one advantage, apart from the historical development, namely that the fundamental laws will have been previously mastered.

The final chapter gives a brief outline of the border-line subject of Radioactivity, and the important considerations of Physical Chemistry, *e.g.*, osmotic pressure, dissociation, the dilution law, thermo- and electro-chemistry, appear in their appropriate places.

Prof. Denham's book presents few strikingly original features, but is quite up-to-date and has evidently been carefully written. Also Messrs. Arnold are publishing it at a reasonable price, and it should therefore find favour in many schools and colleges. J. G. F. D.

Proteins and the Theory of Colloidal Behaviour, by JACQUES LOEB. Pp. XI. + 292. London: McGraw-Hill Publishing Co., Ltd., 6 & 8, Bouverie Street, E.C., 1922. Price 15s.

It was Graham who first suggested the distinction between colloid and crystalloid bodies. When it was found possible for a substance to exist in solution in both conditions it was proposed to distinguish between colloid and crystalloid *states of matter*.

Now, Dr. Loeb maintains that the whole behaviour of what are termed colloidal solutions of proteins is in agreement with ordinary chemical laws, and that when a neutral salt is added to a gelatin solution the protein units in solution react with one ion of the neutral salt only. This view is contrary to that held by most colloid chemists, since it leaves ont of account the adsorption effects.

The author's experimental work has been largely based upon Prof. Donnan's ingenious theory of the equilibria which are established when two solutions of electrolytes are separated by a membrane permeable to all except one ion. This theory has supplied a quantitative and mathematical explanation of the behaviour of protein solutions. Dr. Loeb shows that gelatin in solution is in a critical state when the hydrogen ion concentration is a certain definite amount, namely, pH=4.7, which he

terms the iso-electric point. At this point the gelatin is non-ionised and does not show the phenomenon of cataphoresis.

On the acid side of this point, gelatin forms compounds in which it plays the rôle of a positive radicle in combination with negatively charged ions such as ·Cl′, or ·OH′. When ionised, the gelatin ion is positively charged.

On the basic side of the iso-electric point, gelatin behaves as a negative radicle, combining with such positively charged ions as Na· or H·. When ionised the gelatin ion is negatively charged.

From his experimental results showing that gelatin combines with acids and alkalies according to the stoichiometrical laws, Dr. Loeb definitely assumes that proteins dissolve in water forming true solutions. He criticises Pauli's Hydration Theory of the behaviour of colloid solutions.

The book largely consists of the author's published and unpublished work on the subject, and cannot fail to attract the widest attention. Doubtless his views will be severely criticised in some quarters, but at least they constitute an important advance in the elucidation of the exact nature of colloidal phenomena. J. G. F. D.

Cyaniding Gold and Silver Ores, by H. Forbes Julian and Edgar Smith. Pp. XXIV. + 417. 3rd Edition, 1921. *Charles Griffin & Co., Ltd.* Price 36s. nett.

This well-known and valuable work on the Cyanide process of gold extraction has had an unfortunate history. One of the authors, Mr. H. Forbes Julian, met an untimely death by the foundering of the *Titanic*, and his colleague, Mr. Edgar Stewart, was murdered by natives in Africa in 1916. The war prevented an intended earlier revision.

The third edition now issued has been prepared by Mr. A. W. Allen, a well-known American authority on metallurgical practice.

The work has been entirely re-arranged, and many additions have been made, the recent advances in the knowledge of colloidal chemistry and physics have been brought to bear upon the subject, and two important chapters are given dealing with the colloidal aspect of slimes and precipitates, and the part played by adsorption phenomena in the cyanide process.

Chapters are devoted to Flotation as applied to gold and silver ores, and numerous diagrams are given of the plant now used for cyaniding gold and silver and the methods of precipitation; technical details of great practical value, together with a number of illustrations, are included.

In an appendix at the end of the book an account is given of the researches of Dr. C. Martin upon the production of antidotes for cyanide poisoning, and a set of tables is included, giving the cubical contents of circular cyanide vats of various diameters and depths.

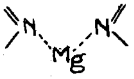
The work is well indexed and has a very complete table of contents.

PHOTOSYNTHESIS.

Although the synthesis of formaldehyde from carbon dioxide has now been definitely demonstrated by Professor Baly, there is little evidence that such a process actually takes place in the plant when carbon dioxide is converted into sugars. The following explanation avoids the necessity of assuming formaldehyde to be one of the intermediate stages of photosynthesis. It may be assumed that:—

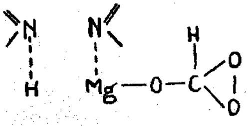
(a) Carbon dioxide and water *add on to* the chlorophyll (I. and II.).

(b) Oxygen is eliminated (III.).

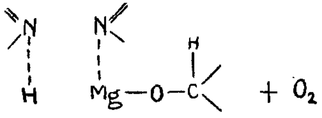


ACTIVE PART OF CHLOROPHYLL

I

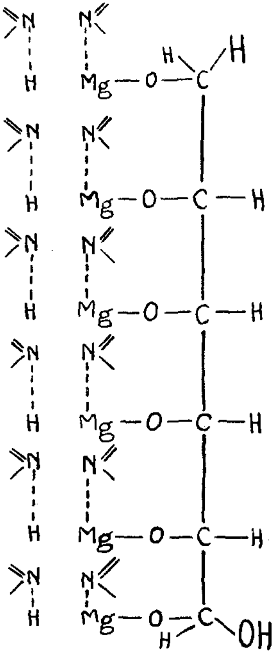


II



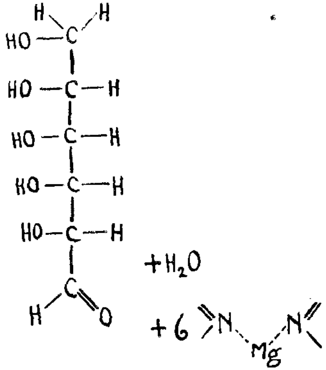
III

(c) Six molecules of the resulting product combine, water being added on (IV.).



IV

(d) The compound IV. is immediately broken up, water is eliminated, and *glucose* formed, the chlorophyll being recovered unchanged (V.).



V

Such an interpretation also accounts for the appearance of only one optical isomer, instead of the racemic mixture which must result from the condensation of free formaldehyde to sugars.

It should be noted that the stages (a) and (b) have been already suggested by Fillstätter.

INSTITUTE OF CHEMISTRY STUDENTS' ASSOCIATION (LONDON).

At the recent first general meeting of the Association, Sir Herbert Jackson, K.B.E., F.R.S., Past President of the Institute, was nominated and unanimously elected first President of the Association. Mr. Marlow expressed Sir Herbert Jackson's regrets that before he had been approached on the subject of the Presidency he had made an appointment for that evening which he was unable to cancel; he hoped, however, on many future occasions, to be at the meetings of the Association, and had expressed his heartiest good wishes for its success.

GENERAL NOTES.

INTERNATIONAL INSTITUTE OF AGRICULTURE, ROME.

PROSPECTS OF WHEAT CROP IN 1922.

From the Bureau of Statistics.

According to estimates communicated to the International Institute of Agriculture by the Governments of a group of countries representing about one half of the Northern Hemisphere wheat crops, their yield in 1922 is 39.5 million metric tons (exclusive of Russia). Compared with the production of the same group of countries in 1921 (36.9 million tons), there is an increase of 7 per cent. This increase is entirely due to the large crop in British India, which surpassed that of 1921 by 3.3 million tons.

In the United States the forecast is for a wheat crop slightly superior (by 3 per cent.) to the previous harvest (22.2 million tons as compared with 21.6 in 1921).

On the other hand, the European estimates of production are decidedly below those of 1921 as regards the few countries which have furnished data. Belgium, Bulgaria, Spain, Finland, Greece, Hungary and Poland give an aggregate of 7.2 million tons in 1922 against their returns of 8.2 million in 1921.

The information to hand from those countries not yet ready to furnish estimates may be summarised as follows: The June rains have somewhat improved conditions for the wheat crop in France, Italy and Czechoslovakia, while the position is fairly good in Bulgaria, Rumania and the Serb-Croat-Slovene State.

The condition of the Canadian wheat crop is reported as generally favourable, apart from some injury by strong winds and hailstorms.

DEFINITION OF RELATIVITY.

In the article on the above, July 21st, page 23, the last two lines of the second column were transposed. The author wishes the word "geometrical" inserted before the word "calculus" in the 12th line from the top of column 2, page 382, in the issue for June 30th last.

LETTER TO THE EDITOR.

[The Editor does not hold himself responsible for the opinions of Correspondents, which may or may not agree with his own.]

July 18th, 1922.

Rome, July, 1922.

SIR,—In view of Sir Robert Hadfields' recent estimate that the ravages of rust and corrosion represent an annual wastage of more than £500,000,000, I beg to draw *your attention to the enclosed particulars* regarding the Association of Manufacturers of Non-Corrodible and Anti-Corrosive Products, which is being formed in order to create new and increased demands for the products and processes of its members.

The following firms have already intimated to me that they are in accord with the formation of such an Association:—

Messrs. Arthur Ross, Hotchkiss & Co., Ltd., boiler preservatives; Messrs. Cuirass Products, Ltd., anti-corrosive paints; Messrs. Henry Wiggin & Co., Ltd., nickel refiners; Messrs. Meldrums, Ltd., acid-resisting chemical plant; Messrs. Thomas Firth & Sons, Ltd., stainless iron and steel.

A meeting will be called as soon as all members of the trade have been approached with a view to being associated as founders of the movement, and the early attention to this matter by any manufacturer will be appreciated.—Yours, &c.,

W. R. DOUGLAS SHAW.

c/o The Royal Society of Arts,
18, John Street, Adelphi,
London, W.C.2.

The objects of the proposed Association and all other particulars can be obtained by application to W. R. Douglas Shaw as above.

New Patents.

This list is specially compiled for *Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

17720—Bloxam, A. G.—Manufacture of aryl esters of phosphoric acid. June 27.

17806—Elektrizitatwerk Lonza.—Manufacture of metaldehyde. June 28.

18074—Imray, O. Y.—Manufacture of aryloxy-naphthyylketones. June 30.

Specifications Published This Week.

160143—Ampere Ges. Rothe, Dr. F., and Diefenthaler, Dr. O.—Process for the manufacture of molybdenum metal or iron molybdenum alloys.

181486—Cederberg, I. W., and Backstrom, H. M.—Method of the catalytic oxidation of ammonia with oxygen.

181509—Gleitz, W.—Process for removing free acids from glycerides

181512—Elektrizitatswerk Lonza, and Busch, A.—Burner for burning metaldehyde.

166887—Niedenzu, Dr. K.—Manufacture of artificial nitrogenous fertilizers.

Abstract Published this Week.

179586.—Phenol-formaldehyde condensation products.—Petersen, W., 6, Lloyds Avenue, London, and Clarke, E. V., 56, St. Annes Crescent, Lewes, Sussex.

An initial liquid condensation product, formed by reaction of phenol with formaldehyde or trioxymethylene in the presence or absence of basic catalysts, is mixed with over 5 per cent. of an organic carboxylic acid, such as lactic, acetic, or formic acid, without any mineral acid, and the mixture is heated until it becomes a viscous liquid which does not adhere to a metal surface. This product, or a solution thereof in alcohol or other solvent, is mixed with a filler, such as asbestos, wood flour, or china clay, to give a plastic mass which can be pressed in moulds. The moulded articles are subsequently converted into hard infusible products by heating. Specification 156,675 is referred to.

Messrs. Rayner & Co. will obtain printed copies of the published specifications, and forward on post free for the official price of 1s. each.

UNIVERSITY OF BIRMINGHAM.

FACULTIES.

Science: Subjects—Mathematics, Physics, Chemistry, Zoology, Botany, Geology, Engineering (Mechanical, Civil, Electrical), Metallurgy, Mining (Coal, Metal, Petroleum), Bio-Chemistry of Fermentation.

Arts: Subjects—Latin, Greek, English, French, German, Italian, Spanish, Russian, Philosophy, History, Music.

Medicine: All subjects leading to Degrees and Diplomas in Medicine and Dentistry.

Commerce: Subjects leading to Degrees in Commerce.

Department of Training for Teachers:
Department of Social Study:

Department of Malting and Brewing.

THE SESSION 1922-23 COMMENCES ON OCTOBER 2nd, 1922.

ALL COURSES AND DEGREES ARE OPEN TO BOTH MEN AND WOMEN STUDENTS.

In the Medical School, Courses of Instruction are arranged to meet the requirements of other Universities and Licensing Bodies.

Graduates, or persons who have passed Degree Examinations of other Universities may, after one year's study of research, take a Master's Degree.

Separate Syllabuses with full information as to Lecture and Laboratory Courses, Fees, Regulations for Degrees, Diplomas, etc., Exhibitions and Scholarships, are published as follows:—

1. Faculty of Science.
2. Faculty of Arts.
3. Faculty of Medicine.
4. Faculty of Commerce.
5. Department of Social Study.
6. Department of Biology and Chemistry of Fermentation.
7. Exhibitions, Scholarships, etc.,

and will be sent on application to the Registrar.

THE CHEMICAL NEWS,

VOL. CXXV., No. 3251

SPORTSMANSHIP IN BUSINESS AND PUBLIC LIFE.

[An Address delivered at the School of Mines and Metallurgy, University of Missouri, by Col. Albert T. Perkins.]

In thinking over what message I might bring to you from the experiences of a rather active career, two factors in making a successful life came into my mind—*loyalty* and *sportsmanship*. I decided to talk to you about *sportsmanship*.

Perhaps you have been used to thinking of sportsmanship as the spirit of fair play in sports or games. But sports and games have all developed as imitations of or idealizations of phases of serious life. The latter is true too of all of our intellectual pleasures—the *drama, music, art.*

You and I have played various games. These games in their present form are the result of centuries of development. Some of you have been hunters, and you have in your mind the distinction between the sportsman hunter and the pot hunter.

You have been playing your games as amateurs. Now you are going to play a bigger game as professionals. The difference between an amateur and a professional is not one of sportsmanship. The idea of the professional is connected up with the necessity of earning one's food and clothes.

Dr. Spaeth—a fine type of sportsman and a rare combination of coach of the rowing crews and Professor of English Literature at Princeton—was saying the other day (as I remember it), "don't go into a game you can't afford to lose; but when you are in the game play it as if you couldn't possibly afford to lose it."

Well, that is sound from the point of view of a game as play. But what you are coming to now is, in baseball language, a long "series," and it will be the "series" which you can't afford to lose, and mustn't lose.

A young athlete wrote to Major Henry Lee Higginson after the latter's inspiring address in dedicating Soldier's Field in June, 1890—"It matters but little the week after, whether a boat race or a football match be won or lost; but let a man or a team do but a single thing which is not entirely manly and aboveboard, and it sets them back in the real race perhaps for years."

So as you come to the commencement of the *real* race I made my subject "Sportsmanship in *Business* and *Public Life.*"

The old adage that "All's fair in love and war" is a relic of the savage state. Treachery is something we at once attribute to the savage or to those in whom the instincts of the savage predominate.

Sportsmanship—fair play—is entirely a product of civilisation, frequently being reverted from here and there, but always in the long run spreading and growing in intensity. Doubtless it influenced war before it did business or civil administration. In the times of those famous sportsman warriors, The Cid Rodrigo de Bivar, Richard Cœur de Lion, and the Chevalier Bayard, it went by the name of "Honour."

You don't expect to take part in a war. Neither did I when I graduated from college. But before I pass to civil business, let me quote you one passage from a sportsman soldier.

The French General, Baron de Marbot, describing in his Memoires the trick played by Marshals Lannes and Murat on the Austrian General, d'Auersperg, in getting hold of the Spitz bridge over the Danube before the battles of d'Essling and Wagram in 1905 (which he estimated would otherwise have cost 30,000 men) says (my apologies to him for my translation): "But was the stratagem of which they made use admissible? I don't think so. I know that in wars between State and State one stretches his conscience under pretext that everything which assures victory may be employed in order to diminish the losses of men, all in giving great advantage to one's country. Still, in spite of these serious considerations, I don't think one ought to approve the means employed to seize the Spitz bridge; as for me I would not do it in like circumstances."

The *Sportsman* in Business—the man of square dealing, of fair play, who has the coolness to meet imperturbed all emergencies! It seems to me a most fundamental requirement is a thoroughly clear realisation that no valid excuse exists for a departure from one's own ideals and rules of conduct, in the knowledge or belief that the other fellow is doing it. That is something where one is often getting into a fog—a mist which arises around one's relations to his employees, to the public, to his business competitors, and to the government.

You may be engaged in what might be called independent professional work, or in the employ of public utilities. But in the past thirty-five years our Government (National and State) has been establishing an increasing control over all business and professional activities. It has been making rules by which the business game is to be played. Many experiments have been tried and many errors made, just as in the development of the football or baseball rules.

Yet there has been undoubted advance in the soundness and fairness of rules made by the government; though the peculiarity of this situation is that as a whole, government in respect to fair play has followed instead of leading.

One might naturally expect that Government would set a good example of fairness in business dealings; but unfortunately many of those handling business affairs of governmental departments have not been brought up in principles of business sportsmanship and their transactions (not for personal gain, but for their departments) have often been of a character abhorrent to the majority of business men.

There seems to be some reaction in that respect, for business men of character and experience are gradually taking more part in governmental affairs.

Now the Government has to come in as a rule maker in business and public utility affairs because the minority would not otherwise play fairly, and the rules had perhaps to weigh heavily both on the fair and unfair players.

It is 35 years since the Interstate Commerce Law was passed. In its early days that was broken in all directions. It took years, with the addition of many modifications and penalties, to make its rules thoroughly effective. The explanation of its violation in any case was almost always that it was to meet the violation by somebody else.

Since then we have had a series of regulatory laws affecting almost all classes of business: and there is a great advance in the willingness and the desire to obey them.

Within this period there has been another marked advance from a widespread feeling among business men that municipal legislators were for sale and had to be purchased even in matters of much concern to the public. The business men who lead have become too good sportsmen nowadays to fall into that sort of thing or to tolerate it on the part of others.

One often hears the statement that railroads and public utilities and other large business corporations have brought their troubles on themselves, coupled sometimes with expressions of sympathy, now that they are trying to do better. But has it not been that the rules were in the making and loose and not enforced by competent umpires and referees; and that those who have worked as sportsmen have frequently been upset by blows below the belt? And the public did not and could not understand all the rules.

The public is always calling for more and better service from its utilities, and properly so. It wants it, too, as cheaply as it can get it. But the public does not and cannot generally understand all the conditions underlying the production of such utilities and the cost of their operation.

On the other hand the managers of most utilities are nowadays doing their utmost to give the public the best service to which their means will stretch.

It seems to me that one of the greatest advances in the matter of fair play has of late years come as in our state, in the transferring of the control and regulation of public utilities from municipalities with their political turmoil and changing policies to a state commission where, whatever its defects, codes of principles and rules may be developed and the rights of both the served and the servers calmly considered.

You still hear and read statements that rates charged by public utilities are high because the utility companies are overcapitalised, i.e., have so-called "watered stocks."

Those statements are based on an entirely wrong impression of the present situation.

Formerly these public utility rates were fixed by local franchises—as 75 cents for gas or 5 cents for street car service. Whatever may have been the effect on confiding investors, it then made no material difference to the public served whether the capitalisation of the serving company were fifty million dollars or one hundred million dollars or one hundred and fifty millions, until such time as the public began to demand more and better service than could be produced for those fixed franchise rates.

Now that is just what the public began demanding. The old franchise rates ceased to meet the requirements, but with their

casting aside, went also any right to a new basis of rates in excess of what should produce a fair rate of return on a fair valuation of the serving property, irrespective of what its former capitalisation may have been—*rates sufficient* and *only sufficient* to pay the cost of producing the quantity and quality o service demanded by the public served.

This producing cost—wages, materials, taxes, and a fair return on a fair valuation of the serving property—the last and in the long run the first of these factors in the *hands of a State commission representing* the people but removed from local influences and prejudices and subject only to review by the courts. The factor of taxes remains in no small degree in the hands of the local communities themselves.

This matter of valuation of existing properties has features of great complexities *and requires the exercise of the highest* degree of wisdom, judgment, and the spirit of fair play on the part of the commissioners; for the valuation now is for fair rate-making purposes. It is the duty of the Commission under the law to make *fair* valuations—*not* unduly *low*, *not* unduly *high*. As time goes on this task will be simpler, for all issuance of new *securities for additional capi*tal investment in public utilities is now under control of the Commission.

Now I have said that in the long run the first factor—wages—is also really under control of the commission, and here it seems to me our spirit of fair play should in *the highest degree come into action. This factor* usually *represents* half *or more* of the rates charged the public. With the cost of material fixed from time to time by market conditions which Commissions cannot at least as yet control, with the valuation or new capitalisation and rate of return fixed by the commission, and the taxes fixed by government authorities, the *public may know* what it is *paying for*, an dthe actual rates of charge for service must depend primarily on the rates of wages (the degree of efficiency being taken fully into account); or vice versa the rates of wages must depend on the charge the utility is permitted to make for service.

So here we have the most serious of all problems—the balance *of the rates* of wages for the various classes of employees serving the public, as between those receiving the wages and the public who pay them.

In a way there is a satisfaction in this situation as it now exists. It brings out clearly that *if* they play fairly the employees of a public utility must give the very best service they are capable of to the public, and the public through their representatives must in return provide for the payment of an adequate and even liberal reward.

You are going into business at a time *when an uncomfortable process of* readjustment of wages and prices is still going on—a time when there is the greatest need on the part of all concerned for a spirit of fair play.

Everybody who works *faithfully* is justified in asking the highest reward he honourably and fairly can obtain for his services; but it is hard to look at these matters from an unprejudiced point of view when one's own private interest is involved. And present conditions are complicated by the fact that in the hurry and stress of war conditions adjustments of wages did not come to all crafts and occupations on an even or proportionate basis.

I find myself in an interesting position at the head of a little army of 6,000 public utility servants, with bad actors for the most part weeded out, and with most of these 6,000 trying their best to do a good job for the public.

In the latter part of 1921 we had, in order to keep within our resources, to make some considerable reductions in wages from the high peak established in 1920. These were made in different degrees in different crafts, after long but amicable conferences and discussions with the committees of those involved, on scales which a combination of several circumstances seemed to make just.

But I am attacked by persons in public life wishing to curry favour with the unthinking sections of the public; but knowing nothing of the comparative deserts or requirements or the so-called working conditions of the employees involved, for not making further and deeper cuts in the wages of employees so that already low rates of fare charged to the public may be further reduced.

So I can't help feeling a greater satisfaction in being in a position where I am on behalf of my men defending against assault wage scales which have been adjusted on a fair basis and which have been approved by a court, instead of fighting for the last possible reduction.

In no way will you gain greater success in the long run than in being real sports-

men in treatment of *those under your* charge—with fairness, frankness, firmness. Most men will go a long way to meet you when they think you are square, and will respond to frankness. For example, we check *all* our conductors *every month*. We tell them they are going to be checked and explain why—so that we can know they are *all right* as the handlers of money. They don't know when they are being checked but *they can always see the results* afterwards. They understand it and no longer worry about spotters spying on them. It is all right when they understand they are simply audited unawares or without knowing just when, just as a bank teller or a post office clerk is.

Remember that it is up to you to set an example of and to teach sportsmanship to those who haven't had your training and advantages.

We haven't needed any for a long time, but we used to have a number of so-called grievance arbitration cases. In one of those a certain minister of the highest character was agreed on by both sides as arbitrator. There was really no doubt about the guilt of the man whose case was in dispute, and the arbitrator so decided. But the head of the guilty man's organisation could see only his own side—to protect one of his constituents and in mailing to the arbitrator a check for his organisation's half of the fee, he enclosed with it a note reading, "God help you as a minister!" Well, that showed bad sportsmanship; but he didn't know any better. Afterwards this labour leader learned better and expressed regret for some things he had said and done.

So you must have patience with these things, continually watch that your own skirts are clear, and results will come.

The most successful and most lasting results come where the dealing is square. That's where, for example, the shining reputation of the A., T. & S. F. Ry. organisation comes from—the outstanding sportsmanship (fairplay, courage, imperturbability) of the late E. P. Riley, impressed on his associates and carried on down through the entire organisation.

So what I preach to you is to carry into your business and professional and public careers the spirit of sportsmanship which has become second-nature to you in your games. No matter how foggy the conditions are, stick to the rules. If you find a rule is wrong try to get it changed in the orderly way.

Give the other fellow, especially anybody under you, all the credit that is coming to him. You will probably get enough credit and more in the long run, enough to balance all the hard knocks and kicks and misrepresentations which you are also sure to get.

Last winter we had a dinner at our St. Louis Harvard Club for one of our Cambridge football coaches, and it did one's heart good to join in the rousing cheers given for Aldrich, captain of the Yale team —our perennial antagonist, as a fine sportsman and a clean player "without reproach." That is the spirit!

ALUMINA.

Hydrolysis of Aluminum Salts.

By Wilder D. Bancroft.

(*From the Journal of Physical Chemistry, June*, 1922.)

Over a century ago, Gay-Lussac[1] found that if one heats a solution of aluminum acetate, it soon becomes turbid and a large amount of alumina precipitates. If the solution is allowed to cool, the precipitate dissolves slowly and becomes transparent. On the reheating and recooling these changes repeat themselves, and this can be kept up indefinitely. With a dilute solution of aluminum acetate the turbidity begins at about 50° and a precipitate forms at a little higher temperature. The precipitate must change gradually because it dissolves more slowly, when the solution is cooled, the longer the heating has lasted. With a more concentrated solution of aluminum acetate the temperature must be raised somewhat higher before turbidity occurs; but this solution also clears up when cooled.

"To determine the amount of alumina precipitated from an acetate solution by heating and the variation with the temperature, there were taken two equal portions of aluminum acetate made by mixing in the cold two solutions of alum and of lead acetate. One of these portions was raised to the boiling-point and filtered at once, while the other portion was precipitated by ammonia. The two precipitates were washed and dried; after which it appeared that the first weighed about half as much as the second.

[1] *Annales de Chimie*, 74, 193 (1810).

"These observations may be very important for the makers of dyed fabrics, for they use the hot solutions of alum and lead acetate in order to get as concentrated solutions of the mordant as possible. A great deal of alumina must precipitate, and the loss will be considerable if the solution is filtered at once. To avoid this it is necessary to let the solution cool completely before filtering or decanting off the mother liquor, and it is also necessary to stir vigorously so as to be certain that all the alumina redissolves. Unless these precautions are taken, the aluminum acetate will be very acid, which is probably the reason for usually adding chalk. It is nevertheless easy to prevent the precipitation of alumina when an aluminium acetate solution is heated, by adding alum. As is well known, alum dissolves alumina and therefore keeps the solution of aluminum acetate from becoming turbid. A large excess of acid will accomplish the same result."

"The precipitation of alumina on boiling and the redissolving at a lower temperature are facts which are of interest to the general theory of chemistry, and which are rather exceptional. If the precipitation were due to volatilization of the acetic acid, the alumina would not redissolve when the temperature is lowered. As a matter of fact similar changes can be observed in a strongly acid solution or in hermetically sealed flasks. Since the precipitation does not depend on the volatilization of the acid, it is evident that it is due to the heat which wrenches apart the molecules of acid and alumina, carrying each out of the sphere of action of the other, and causing their separation. With less heat the same molecules come within each other's sphere of activity and combine."

Gal-Lussac is practically saying in other words what we now designate as reversible hydrolysis. In 1854 Crum[1] prepared colloidal alumina from a weaker and more basic solution than that used by Gay-Lussac. "By the continued action of heat on a weak solution of binacetate of alumina, $Al_2O_3(CH_3CO_2)_4(OH)_2$, a permanent separation of the constituents of the salt takes place, although no acid escapes and no alumina is precipitated. The properties of the alumina are at the same time materially changed. A solution of binacetate of alumina diluted so as to contain not more than one part of alumina in two hundred of water, was placed in a closed vessel which was immersed to the neck in boiling water, and kept in that state day and night for ten days. It had then nearly lost the astringent taste of alum, and acquired the taste of acetic acid. Being afterwards boiled in an open capsule, acetic acid was freely given off, and when the boiling had continued about five hours (the loss of water being continually restored), the liquid was found to have retained not more than one-eleventh of its original quantity of acetic acid, or about one equivalent to five and a half of alumina."

[1]*Jour. Chem. Soc.*, 6, 225 (1854).

The theory of this is very simple. Water will hydrolyze any salt until the product of the concentrations of the hydrogen and hydroxyl ions reaches a value of about 10^{-14}. If either base or acid is very sparingly soluble, the hydrolysis will run farther than if both are strong electrolytes. Equilibrium will be reached much more rapidly if the solution is heated. Whether the insoluble base precipitates or remains in colloidal solution will depend on the conditions of the experiment. That hydrolysis has taken place can be shown in a number of different ways. Gay-Lussac deduced it from seeing the precipitated alumina, and Crum from the change in the taste of the solution. One could measure the change in acidity in other ways than by the sense of taste. Debray[1] showed that if a dilute solution of ferric chloride is heated to 70° it no longer reacts with potassium ferrocyanide to form Prussian blue. The reason for this is that there is no more ferric salt in solution, it having been converted completely into colloidal ferric oxide. Colloidal ferric oxide is not blackened by hydrogen sulphide. On the other hand it is precipitated from apparent solution either by sodium sulphate or by sulphuric acid, a behaviour which is distinctly not characteristic of ferric chloride. Wiedemann[2] has used the magnetic properties as a means of following the hydrolysis, because the atomic magnetism of the iron in colloidal ferric oxide is only one-fifth that of the iron in a strongly acid solution of ferric chloride. Colloidal solutions of the hydrous oxides can be obtained by hydrolysis of the

[1]*Comptes rendus*, 68, 913 (1869).
[2]*Pogg. Ann.*, 135, 218 (1868); *Wied Ann.*, 3, 45 (1878).
[3]*Jour. Soc. Chem. Ind.*, 2, 587 (1883).

acetates, nitrates, or chlorides; but not in general by hydrolysis of sulphates, because sulphuric acid precipitates the colloidal solutions more readily than does hydrochloric, nitric, or acetic acid.

In 1883 Liechti and Suida published some work on the hydrolysis of solutions of aluminum salts. Their original paper is not in the John Crerar Library, the Library of Congress, or the Library of the Franklin Institute. I have therefore made use of the lengthy abstract by J. J. Hummel.[1] *With aluminum sulphate ($Al(SO_4)_3.18H_2O$, 200 g per litre) there was no visible hydrolysis on heating or on diluting. With $Al_2(SO_4)_2(OH)_2$ made from 200 g $Al_2(SO_4)_3.18H_2O+31.82$ g Na_2CO_3 per litre, there was no visible change on heating; but a precipitate formed when the solution was diluted fourteenfold. With a solution three-quarters as concentrated, there was no visible change on heating, but dissociation took place on diluting tenfold. Since three-fourths of fourteen is ten and a half, this shows the error in determining the beginning of visible hydrolysis. With time. The general results are that hydrolysis takes place more readily on heating and $Al_4(SO_4)_5(OH)$, made from 200 g $Al_2(SO_4)_3.18H_2O+45.7$ g $NaHCO_3$ per litre a jelly was formed on heating and a precipitate remained on cooling. Diluting to one-half caused a precipitate to appear in the cold. With $Al_2(SO_4)(OH)_4$, made from 300 g $Al_2(SO_4)_3.18H_2O+151.3$ g $NaHCO_3$ per litre, the solution kept only a short on diluting, the more basic the solutions. The statement is made that sodium sulphate accelerates the dissociation. If this is true, it must be because the sodium sulphate decreases the hydrogen ion concentration by reacting with the sulphuric acid to form acid sodium sulphate. Since sodium sulphate coagulates colloidal alumina, it may be that it has practically no effect on the hydrolysis; but causes the precipitate to become visible sooner. In other places Liechti and Schwitzer*[2] *say that they have proved that sodium sulphate retards the decomposition. There must be a misprint somewhere.* A retarding of the decomposition would be more in line with the observation by Schmid that sodium sulphate retards the precipitation of alumina *by sodium carbonate.*

With what they call a sulpho-acetate, $Al_2(SO_4)(CH_3CO_2)_4$, made from 200 g $Al_2(SO_4)_3.18H_2O$ + 227.6 g $Pb(CH_3CO_2)_2$ per litre, a precipitate formed on heating to 90° and a jelly on heating to 100°. The solution cleared up on cooling. There was no precipitate on diluting sixty-fold. On adding sodium bicarbonate to this so-called sulpho-acetate, Liechti and Suida obtained solutions of what they called basic sulpho-acetates, from $Al_2(SO_4)(CH_3CO_2)_3(OH)$ down to $Al_2(SO_4)(CH_3CO_2)(OH)_3$. There is no real reason for assigning these formulas to these solutions. In the first place there is no obvious reason why the sodium bicarbonate should take acetate rather than sulphate out of the aluminum salt. It would be distinctly more reasonable to consider the basic compounds as varying from $Al_4(SO_4)(CH_3CO_2)_4(OH)_2$ to $Al_2(CH_3CO_2)_3(OH)_3$. Probably the reason for not doing this was that these solutions did not behave like basic acetate solutions obtained by adding sodium bicarbonate to aluminum acetate; but that does not prove anything *because these latter solutions do not* contain sodium sulphate. In the second place there is no reason to suppose that Liechti and Suida ever had a sulpho-acetate solution. The so-called sulpho-acetate solution was undoubtedly merely a mixture of $^1/_3$ $Al_2(SO_4)_3$ and $^2/_3$ $Al_2(CH_3CO_2)$. *Similarly there is no satisfactory evidence of the existence of any of the alleged basic compounds. They may perfectly well have been aluminum sulphate or aluminum acetate or a varying mixture of both with peptized alumina. Liechti and Suida undoubtedly thought they were dealing with true basic salts because of their getting an apparent solution; but it is quite evident, even from the abstract, that they knew nothing about colloidal solutions. The formulas which are written therefore indicate the relative amounts of sodium bicarbonate which have been added to the original solution and nothing more than that. This point seems to have been overlooked by all the people who have discussed this* work.

The so-called basic sulpho-acetates all formed jellies on heating and all formed precipitates on dilution, the temperature at which the first turbidity occurred being lower the more basic the solution. Less water had to be added to cause precipitation as the solution became more basic. With straight aluminum acetate, made from 200 g $Al_2(SO_4)_3.18H_2O$ + 341.4 g $Pb(CH_3CO_2)_2$ per litre, there was no turbidity on heating and no precipitation on cooling. This result does not contradict

[1] *Mitt. techn. Gewerbe-Museums in Wien, Sektion für Färberei*, 3, 59, 60 (1886).

ing with a more dilute solution. All the so-called basic aluminum acetates formed precipitates or jellies on heating which did not dissolve when the solutions were cooled. The one with the alleged formula $Al_2(CH_3O_2)_4(OH)_2$ precipitated on dilution; but the more basic ones did not. This may only be a question of a time factor. If not, sodium acetate must peptize alumina strongly.

By adding sodium carbonate to aluminum chloride, solutions were obtained having the analytical compositions, $Al_2Cl_5(OH)$, $Al_2Cl_4(OH)_2$, $Al_2Cl_3(OH)_3$, $Al_2Cl_2(OH)_4$. None of these solutions become turbid either on heating or on diluting. Leichti and Suida were not able, however, to make these alleged solutions synthetically. "The solubility of aluminum hydrate in aluminum chloride was tested, and the following remarkable results were obtained. To a solution of Al_2Cl a quantity of aluminum hydrate was added sufficient to form the basic salt $Al_2Cl_4(OH)_2$. The alumina dissolved only on heating, and the solution remained clear on cooling. To this clear solution a further quantity of aluminum hydrate was added, sufficient to form the compound $Al_2Cl_2(OH)_4$. It was, however, found that no more alumina could be made to dissolve, the precipitate even increasing, and on filtering it was found that the solution contained equal molecules of normal Al_2Cl and of HCl. The nascent $Al_2Cl_2(OH)_4$ had apparently decomposed according to the following formula:

$$7\ Al_2Cl_2(OH)_4 + 2\ H_2O = 5\ Al_2(OH) + 2\ Al_2Cl + HCl.$$

In the same way it was proved that, on adding aluminum hydrate to $Al_2(SO_4)_3$ solution sufficient to produce the basic compound $Al_4(SO_4)_3(OH)$, no alumina at all dissolved, the filtrate only containing $Al_2(SO_4)_3$. Here, too, we must suppose that the nascent basic compound decomposes as follows:

$$Al_4(SO_4)_3(OH) = Al_2(OH) + Al_2(SO_4)_3."$$

We know that hydrous ferric oxide, if present in excess, will remove from suspension all the chromic oxide[1] peptized by caustic alkali; but nobody has studied the removal from suspension of a substance by an excess of itself, unless perhaps we have such a case in the Bayer process for the purification of alumina. Since Liechti and Suida were obsessed with the idea of basic compounds, they made no experiments to see whether addition of sodium chloride would cause more alumina to go into apparent solution. According to Schmid[1] sodium sulphate retards the precipitation of alumina.

1 Nagel: *Jour. Phys. Chem.*, 19, 331

A whole series of so-called basic nitrate solutions were made up by adding sodium bicarbonate to aluminum nitrate solutions. None of these solutions became turbid either on heating or on dilution. The sum total of all these experiments is that basic aluminum acetate solutions hydrolyze very readily because the resulting acetic acid is a weak acid; that basic aluminum sulphate solutions become turbid because of the coagulating action of the sulphates, this more than counterbalancing the effect due to the strength of sulphuric acid; and that basic aluminum chlorides and nitrates do not become markedly turbid because the acids are strong ones having low coagulating powers.

Although Liechti and Suida got no cloudiness with their aluminum sulphate solution on heating, that may have been a question of concentration or of time, for Naumann[2] reports that "when a solution of potash alum is heated to the boiling point of water, a white precipitate is formed, which, after washing with water, is an amorphous powder, with an admixture of glittering laminæ, and dissolves with difficulty in strong hydrochloric acid, but easily in potash. The precipitate contains 31.2–32.6 per cent. of alumina, about 11 per cent. of potash, 30–40 per cent. of sulphuric acid, and water; and is therefore a more or less basic compound of alumina, potash, and sulphuric acid, with water. It was found that with pure alum solutions the decomposition was most rapid at first, gradually becoming less for equal intervals of time, so that a state of equilibrium in the liquid was reached only after a very long time. Dilution of the solutions favoured decomposition. Free sulphuric acid, added to alum solutions, prevented the decomposition, partially or entirely, according to the amount added. Neutral potassium sulphate, on the contrary, expedited the decomposition."

There is a good deal of uncertainty as to what compounds are formed when salts of aluminum are boiled or are treated with soda. Cajar[3] states that the action of soda on cold aluminum sulphate solution gives a white precipitate which covers well;

1 *Jour. Soc. Chem. Ind.*, 14, 654 (1895).
2 *Ber. deutsch chem. Ges.*, 8, 1639 (1875); *Jour. Chem. Soc.*, 29, 682 (1876).
3 *Zeit. angew. Chem.*, 27, 793 (1911).

whereas a more transparent precipitate is obtained when the soda is added to a hot sulphate solution. Underwood[1] states that *alumina precipitated* cold with sodium carbonate contains basic sulphate and dries soft and powdery; but that it dries horny *when precipitated hot.* Jennison[2] says that the hydrate of aluminum, $Al_2(OH)$, "is produced when caustic soda or potash, *ammonium hydrate or carbonated alkalies* is added to a solution of an aluminum salt; it is soluble in caustic alkalies, and therefore *is usually obtained* by *means of* the carbonates. When produced from cold, dilute solutions, it is of a transparent, gelatinous *nature; but,* on *heating, becomes* opaque and more contracted in bulk. With carbonated alkalies it is must denser and is very *lumpy, owing to the reaction being* incomplete. Aluminum hydrate, when dried, forms a hard, white, horny *substance, which has the composition* of $Al_2(OH)$, and only on ignition is the whole of the water driven off, leaving Al_2O_3."

According to Knecht, Rawson and Loewenthal a crystallised basic sulphate, $Al_2(SO_4)_2(OH)_2$, has been placed on the market by Messrs. Peter Spence and Co., Ltd. Schlumberger[4] claims that there is one basic sulphate of aluminum. On adding 4.5 mols of caustic potash to a sorution containing one mol of aluminum sulphate, the supernatant liquid was still distinctly acid. On adding 5 mols KOH the solution was neutral and contained no aluminum salt. On adding 6 mols KOH the supernatant liquid was alkaline and contained some alumina, *presumably as potassium aluminate.* The precipitate must therefore analyse for $(Al_2O_3)_2SO_3\chi H_2O$ where χ is not less *than six. Actually it came out* seven, so Schlumberger writes the formula of the basic salt $(Al_2O\ H\ )_2.H_2SO_4$. Of course, it will be noticed that he analysed a precipitate obtained only under one set of conditions. While it may be that he was dealing with a definite compound, there is nothing in his experiments to prove it. He should have analysed the precipitate after adding three or four mols of caustic potash and have shown that it had exactly this same composition. Then his results could have been accepted as proving something. This is *the more* necessary because many basic aluminum sulphates are to be found in the books.[1] Böttinger contributes a new *one of his own* by evaporating repeatedly to dryness a mixture of aluminum sulphate and sodium chloride at 130°-140°. This one analyses *for* $Al_2O_3.SO_3.6H_2O$ or $Al_2O\ H\ .H_2SO_4.2H_2O$ if we adopt Schlumberger's way of writing the formula.

1*Underwood and Sullivan*: "*Printing Inks*," 81 (1915).

2"*The Manufacture of Lake Pigments from Artificial Colours*," 51 (1900).

3*Bull. Soc. chim. Paris*, [3] 13, 41 (1895).

4"*A Manual of Dyeing*," 225 (1910).

Adsorption of Aluminum Sulphate by Wool.

Since the different salts of aluminum *hydrolyze* of themselves under suitable conditions, they should hydrolyze even more readily in presence of a textile fibre which adsorbs the alumina and they do as a matter of fact. In so far as the acid radical is also adsorbed, there may be minor complications *and the matter may seem less simple* than it really is.

When wool is treated with aluminum sulphate, $Al_2(SO_4)_3.18H_2O$, less than about five per cent. on the wool, the bath is exhausted completely, all the alumina and all the sulphuric acid being taken up.[3] With *higher concentrations, more and more* aluminum sulphate is left in the bath. There has been some discussion whether the wool takes up *aluminum sulphate or alumina* and sulphuric acid in the cases when the bath is exhausted completely. When wool mordanted in this way is boiled with water, the wash water is always acid, sulphuric acid being removed slowly and alumina left behind. This has been considered by von Georgievics[8] as a proof that the sulphuric acid is free. While this may be true, it does not follow, because the adsorbed *aluminum sulphate might be hydrolyzing.* It is much wiser to admit frankly that we have no way at present of deciding this point. In case the acid is not combined in definite proportions, the next problem is whether it is adsorbed by the alumina, by the wool, or by the two in some unspecified ratio.

1*Böttinger*: *Liebig's Ann.*, 244, 224 (1888).

2*Liechti and Schwitzer*: *Mitt. techn. Gewerbe-Museums in Wien, Sektion für Färberei*, 3, 47 (1886).

3*Chem. Centralblatt*, 1895, 402; *Binz and Rung*: *Zeit. angew. Chem.*, 1908, 628.

Ganswindt [1] gives some data by Fürstenhagen and Appleyard [2] on the mordanting of wool by potash alum, which are reproduced and extended in Table I.
105.

TABLE I.

25.4% sulphuric acid in potash alum.

Potash alum referred to wool. Concentration per cent.	Sulphuric acid referred to potash alum. Wool per cent.	Solution per cent.
5	25.4	0.0
10	22.1	3.3
15	14.6	10.8
20	11.0	14.4

Sulphuric acid referred to wool. Wool per cent.	Solution per cent.
1.27	0.0
2.21	0.3
2.19	1.6
2.20	2.9

In the first column are the amounts of potash alum referred to the weight of wool. In the second and third columns are the percentages of sulphuric acid in the total amount of alum in the wool and the bath respectively. At 5% alum all the sulphate is taken up, but with higher concentrations of alum more of the sulphuric acid stays in the bath. Since determinations on the alumina adsorption are not given, we cannot tell to what extent alumina is adsorbed more than sulphuric acid. Since this method of presentation is not the usual one, I have added two columns to show the percentage of sulphuric acid referred to wool, taken up by the wool and left in the bath respectively. If these figures are to be trusted, the amount of sulphate adsorbed by the wool is practically constant when the bath contains 10%–20% alum referred to the wool. It is probable that this is not strictly true.

1 "*Theorie und Praxis der modernen Färberei*," II., 83 (1902).

2 *Jour. Soc. Dyers and Colourists*, 1888,

(To be Continued.)

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.

The report described below has been published by His Majesty's Stationery Office for the Department of Scientific and Industrial Research. Copies, price 4s. (by post 4s. 3d.) may be obtained through any bookseller, or direct from H.M. Stationery Office at the following addresses:—

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FIRST REPORT OF THE ADHESIVES RESEARCH COMMITTEE.

This report embodies the results of certain of the investigations initiated by the Adhesives Committee of the Conjoint Board of Scientific Societies, and also the researches of a more fundamental character which have been undertaken by the Adhesives Research Committee of the Department of Scientific and Industrial Research. The report is thus a comprehensive summary of the work from its inception in 1918, up to the end of 1921.

The contents of the report are arranged under the following headings:—

I. Introduction.
II. *Mechanical Tests of Adhesives for* Timber.
III. Casein Adhesives.
IV. Gelatin Adhesives.
V. Vegetable Adhesives.
VI. Other Adhesives.
Appendix I. Descriptive Bibliography of Gelatin.
Appendix II. The Bearing of Results obtained in recent Investigations of Soap Systems upon the Structure of Gelatin Gels.

The first appendix is a comprehensive survey of the scientific literature of gelatin viewed from the physico-chemical standpoint.

The report is illustrated by diagrams and photographic plates.

NOTE ON DINITROBENZIL.

BY E. DE BARRY BARNETT, B.SC., F.I.C., AND L. J. KAY, B.SC.

If the "bridge" bond formula for anthracene is correct, it should be possible to syn-

thesise anthracene derivatives from compounds in which two benzene rings are joined by a normal chain of two carbon atoms. The most readily obtained compounds of this class are the benzoins and benzils, and experiments have been carried out with the object of converting these into anthracene derivatives. So far no success has been attained, but during the course of the research it became desirable to prepare dinitrobenzil, and the object of this note is to point out that the preparation of this compound is very much more simple than would be gathered by a study of the literature.

The first description of the nitration of benzil is recorded in a paper by Zagumenny (*Journ. Russ. Chem. Soc.*, 1872, 4, 278), who boiled benzil with fuming nitric acid, and seems to have obtained a mixture of isomers. Shortly afterwards Poirrier and Rosenthiel (*D.R.P.* 44269) claimed that dinitrobenzil is obtained when benzoin is boiled with fuming nitric acid, but no details of the preparation are given in the patent. More recently Klinger and Martinoff (*Annalen*, 1912, 389, 234) have studied the nitration of benzil. Although they state that the nitration can be effected with a mixture of nitric and sulphuric acids, they recommend the use of water-white absolute nitric acid (D=1.53) at 2°. The preparation of such an acid is troublesome and is totally unnecessary, as it has now been found that the nitration of benzil takes place extremely smoothly when effected by a mixture of nitric and sulphuric acids. The resulting 3:3′-dinitrobenzil is obtained in almost theoretical yield and in a very pure state. The following are the details of the nitration:—Benzil (16 grams) is dissolved or suspended in 80 cc. of concentrated sulphuric acid and 16 grams of finely powdered potassium nitrate added in small amounts during half an hour. The whole is then allowed to stand over night, and the resulting thick yellow paste poured slowly into a large volume of cold water. The precipitate is collected, washed free from acid, and recrystallised from boiling alcohol. The resulting yellow needles are quite pure, and melt sharply at 109°.

As no derivatives of dinitrobenzil seem to have been prepared, it was thought advisable to prepare and analyse the phenylhydrazone. In spite of the two carbonyl groups dinitrobenzil only forms a monophenylhydrazone under ordinary conditions. This was obtained when 3 grams of dinitrobenzil were dissolved in 100 cc. of warm alcohol and a solution of 2 grams of phenylhydrazine in a little 50 per cent. acetic acid added, and the whole boiled under reflux for an hour. On cooling, the monophenylhydrazone separated out and was purified by recrystallisation from glacial acetic acid. It melts with decomposition at 159°. (Found: N=14.41 C $H_{13}O_5N_4$ requires N=14.40 per cent.).

Several attempts were made to convert the dinitro-compound into a tetra-nitro-compound by further nitration, but the dinitro-compound was always recovered unchanged. This was even the case when a nitrating acid containing 20 per cent. of free sulphur trioxide was employed.

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E.C.3

GENERAL NOTES.

ROYAL SCHOOL OF MINES FRECHEVILLE RESEARCH FELLOWSHIPS.

The Imperial College of Science and Technology, South Kensington, London, S.W.7, with which the Royal School of Mines is incorporated, is offering two Research Fellowships of £300 a year each, tenable for one year and possibly renewable for a second year, to aid in carrying out any investigation or research connected with Mining, Mining Geology, Metallurgy, or the Technology of Oil, which in the opinion of the Selection Committee is of sufficient use or promise.

Applicants, who may be Associates of the Royal School of Mines or others, and preferably men with some practical experience, should apply in writing to the Secretary of the College (from whom further particulars may be obtained) before 1st September, 1922, giving the nature of the proposed investigation, qualifications for the work and references.

It is anticipated that the Committee will make the awards by the end of November, so that the Fellowships and work may begin on 1st January, 1923. Holders will be expected to devote their whole time to the work, which may be conducted at the Imperial College, or in special circumstances elsewhere at the discretion of the Committee.

THE BOARD OF TRADE.

SAFEGUARDING OF INDUSTRIES ACT.

Part I.; Arbitrations under Section 1 (5).

Judgment has been given by the Referee in the matter of a complaint under the above Sub-Section that R. Sodium Hyposulphite (otherwise Sodium Thiosulphate) has been improperly included in the lists of articles chargeable with duty under Part I. of the Act. The Referee has awarded that the grade of this chemical covered by the term R. Sodium Hyposulphite is properly included amongst the articles liable to duty and that the complaint therefore fails. The Referee, however, directs that, for the sake of clearness, as the grade so covered is commonly known as "photographic quality," the words "photographic quality" should be inserted in the lists after the words "Sodium Hyposulphite." As from the date hereof the lists will accordingly be amended as follows:—

For "R. Sodium Hyposulphite" read "Sodium Hyposulphite (photographic quality)."

For "R. Sodium Thiosulphate" read "Sodium Thiosulphate (photographic quality)."

QUALITATIVE TEST FOR URANIUM.

H. D. BUELL.

A solution of the ore or slag to be tested is made in nitric acid, a large excess of which is not needed. Granulated zinc is then added, when in the presence of uranium a yellow deposit on the zinc will be formed. Using uranium nitrate, 0.88 mg. per cc. of solution could be detected by this means. HCl or H_2SO_4 should not be present, as in such cases a black deposit is produced. Iron and vanadium must not be present in large quantities, but the test is not interfered with by gold, platinum, thorium, lead, tungsten, titanium, mercury, chromium, or copper.—(*J. Ind. Eng. Chem.*, 1922, p. 593.)

SYNTHESIS OF UREA.

An investigation into the large scale production of urea from ammonia and carbon dioxide has been undertaken by Krase and Gaddy (*J. Ind. Eng. Chem.*, 1922, p. 611). The first step of the process is the preparation of ammonium carbonate from ammonia and CO_2, and in this direction the use of liquid ammonia was not found satisfactory. It was ascertained that for the present purpose, the condensation of the requisite amounts of ammonia gas, carbon dioxide and water vapour gave good results, and the condenser was fitted with a rotating blade by which the ammonium carbamate was continually removed. Not more than 1.5 per cent. water should be present in the carbamate, otherwise it has an adverse effect on the yield of urea. The ammonium carbamate is now made into briquettes, which are introduced into an autoclave and heated to 150° C., when conversion into urea takes place. The so-called sludge from the autoclave has next to be distilled in a current of CO_2 in order to remove unchanged ammonia. On a large scale arrangements are such that the process is practically continuous.

OXIDATION OF POTASSIUM ACETATE TO POTASSIUM OXALATE.

W. L. LLOYD AND P. R. HINES.

The authors find that potassium acetate can be oxidised with alkaline permanganate to potassium oxalate. This is contrary to the findings of Denis (*Am. Chem. Jour.*, 1907, p. 568), but such differences are found due to conditions at the time of the experiment, time, concentration and temperature having a bearing on the reaction.

NOTE.

Referring to a letter by John Missenden, published in our issue of July 7th, dealing with research, we have received a further communication from the same source, giving the name of H. P. Sholl, of 1, Maxted Park, Harrow, who is prepared to undertake research work in the field of Organic Chemistry.

INDUCED REACTIONS AND MECHANISM OF CHEMICAL CHANGE.

By N. R. Dhar.*

[In a foregoing paper (Trans. Faraday, Soc., 1921; Chemical News, December 16, 1921) it has been proved that the phenomenon of induced oxidation is of general occurrence.

In this paper several other induced reactions have been investigated. A very brief outline of recent work on the mechanism of Chemical Changes has also been given.]

* *A part of the Presidential Address at the Chemistry Section of the Indian Science Congress*, 1922.

Oxidation has now been induced in the following substances in presence of sodium sulphite which was itself oxidised by passing oxygen gas through the mixtures:—

Urea, starch, grape sugar, cane sugar, potassium oxalate, sodium acetate, sodium potassium tartrate, sodium formate, sodium citrate, acetone, chloral hydrate, chloroform, glycerol, quinine sulphate, sodium succinate, methyl alcohol, phenol, glutaric acid, maltose, potassium stearate, cholesterol, anthraquinone, acetanilide, brucine, phenolphthalein, and gum arabic.

The oxidation of ferrous hydroxide, freshly precipitated and carefully washed free from alkali, by passing oxygen through it in water induces the oxidation of the following substances:—

Urea, starch, grape sugar, cane sugar, potassium oxalate, sodium acetate, sodium potassium tartrate, sodium formate, sodium citrate, acetone, chloral hydrate, glycerol, quinine sulphate, sodium benzoate, sodium succinate, methyl alcohol, phenol, phenolphthalein, and gum arabic.

In the following cases of oxidation, either in presence of sodium sulphite or freshly precipitated ferrous hydroxide along with carbon dioxide, the presence of aldehyde (which is an intermediate product of oxidation) was detected by Schiff's reagent:—

Methyl alcohol, ethyl alcohol, amyl alcohol, glycerol, glutaric acid, phenol, and brucine.

In the case of oxidation of benzyl alcohol, acid test was obtained with litmus.

The wide application and the general usefulness of these induced reactions are evident from the fact that these various compounds which do not undergo oxidation by oxygen under ordinary conditions can be readily oxidised when they are mixed with sodium sulphite or ferrous hydroxide, which is itself being oxidised.

It is evident that there will be different stages of oxidation of these organic compounds until the final products of oxidation are obtained.

Relation to Life Processes.

It is impossible to ignore the importance of these reactions in their relation to the phenomena of oxidation and reduction in the animal body. It is well known that a molecule of stearic acid taken into the body in the form of fat undergoes combustion, so that eventually each of its eighteen carbon atoms will be converted into carbon dioxide, but no one imagines that such a change is immediate or direct—that every carbon atom simultaneously parts with its attached hydrogen atoms, and by combining with oxygen yields carbon dioxide and water. We have brought about the same change in the laboratory with potassium stearate by inducing its oxidation by the primary oxidation of sodium sulphite or ferrous hydroxide by passing oxygen through the mixture at the ordinary temperature.

In the animal body, acetic acid is oxidised with great ease to carbon dioxide and water. Its oxidation in the laboratory has been effected by us with the help of sodium-sulphite or ferrous hydroxide when it is being oxidised by passing oxygen through it.

The substance undergoing active metabolism in the animal body, comprising the proteins, carbohydrates, fats and their derivatives, are practically entirely resistant to oxidation by oxygen under ordinary conditions, yet in the animal body the carbon of all these types of compounds is readily oxidised to carbon dioxide. It is generally conceded that some process of activation of the atmospheric oxygen must take place in the body in order to account for the observed chemical changes. It is remarkable that a very large number of such biochemical oxidations have been imitated in the laboratory by the simple process of induced oxidation as already mentioned. We are now engaged in further generalising this type of induced oxidation and in finding out the intermediate products of oxidation in these cases.

It has been shown in a previous paper that the oxidising power of hydrogen peroxide is greatly accelerated in presence of ferrous and ferric salts; thus if tartaric

acid or starch and hydrogen peroxide be brought together at the ordinary temperature hardly any chemical reaction takes place, but as soon as a ferrous or a ferric or starch rapidly takes place (*Dhar., Jour. Chem. Soc.*, 1917, III., 694). There is a *great importance of reactions of this type* in the explanation of oxidations in the human body. The food in the animal body is oxidised by the atmospheric oxygen giving us heat and energy. In the animal body there is evidence with regard to the formation of a peroxide from the oxygen taken up by the animal and this peroxide oxirises the food taken up in the body.

Explanation of the Use of Iron Salts in Medicine.

As we have shown in the laboratory, *that iron salts (either ferrous or ferric)* markedly accelerate the oxidising power of the peroxide, similarly in the animal body *the iron in hæmoglobin present in the blood* catalytically accelerates the oxidation of the food stuff by the peroxide formed in the body from the inhaled oxygen. Now when there is deficiency of iron in the blood, the animal body suffers from anæmia because the amount of catalyst necessary for rapid oxidation falls short. At this stage any *iron salt taken in the system will supply* the natural deficiency, and the necessary amount of oxidation will take place. This is the *probable* mechanism of the internal use of iron salts, whether ferrous or ferric, in medicine. It has also been observed that induced oxidation can take place in the acetic fermentation of alcohol.

Induced Precipitation.

The phenomenon of induced precipitation is of common occurrence. When any one of the phosphates of iron, aluminium, or chronium is precipitated by *sodium* phosphate in presence of acetic acid and calcium chloride, the precipitate after being thoroughly washed with acetic acid, gives test for calcium with ammonium oxalate.

Similarly strontium or barium phosphate is *precipitated along* with ferric phosphate or aluminium phosphate or chronium phosphate, even in presence of acetic acid.

When any of the hydroxides of iron, aluminium or chronium is precipitated in an excess of concentrated ammonium hydroxide in presence of copper sulphate, zinc sulphate, nickel chloride or cadmium nitrate, the precipitates, *even after* being thoroughly washed with concentrated ammonia gives test for the ions in presence of *which the precipitation has* been carried out.

When calcium, strontium or barium carbonate is precipitated by means of ammonium carbonate from any of their soluble salts containing a little of magnesium chloride, the precipitate after being thoroughly washed with ammonium chloride shows the presence of magnesium.

Moreover, when a little of sulphuric acid is added to a solution of calcium or strontium, or barium chloride containing ferric or chromium or aluminium salt, the precipitated sulphates of calcium, strontium or *barium contain iron, or aluminium or chromium.* Similarly lead sulphate is precipitated along with barium sulphate, even in presence of a large excess of ammonium acetate.

Magnesium oxalate is precipitated with barium or strontium or calcium oxalate, in presence of an excess of ammonium chloride and ammonia.

These facts make it clear that the phenomenon of induced precipitation is of very general occurrence.

Copper and Nitric Acid.

The action of copper on 20 per cent. nitric acid, though slow at the ordinary temperature, can be accelerated by the inductor nitrous acid. If two pieces of copper wire are put into two test tubes containing the same amount of 20 per cent. nitric acid and one of the tubes kept at *rest*, whilst the other is vigorously shaken, it will be found that, contrary to our ordinary experience, the copper in the tube at rest will dissolve much more quickly, because the inductor nitrous acid formed by the action of copper on nitric acid remains in contact with the copper in the tube at rest, whilst in the other case, the inductor is diluted throughout the whole mass of nitric acid.

On investigating these various cases of induced reactions, we were naturally led to the more general conclusion that one chemical change should induce another chemical change of the *same type*, and we tried to verify this conclusion. We found that the reduction of mercuric chloride by such different reducing agents as formic acid, sulphurous acid, phosphorous acid, etc., induce in all cases the reduction of the same substance, *e.g.*, mercuric chloride, by sodium arsenite. We also investi-

gated other changes, as for instance, the decomposition of unstable substances.

POTASSIUM CHLORATE DECOMPOSES MORE READILY IN PRESENCE OF DECOMPOSING AMMONIUM BICHROMATE OR POTASSIUM PERSULPHATE.

It is well known that ammonium dichromate decomposes readily into nitrogen, water and chromium oxide, also the decomposition temperature of potassium persulphate is lower than that of potassium chlorate, and it has been found that in presence of decomposing ammonium dichromate or potassium persulphate, the decomposition temperature of potassium chlorate is appreciably lowered. In this connection it will be of interest to investigate whether the presence of an easily decomposable explosive will lower down the decomposition temperature of a difficultly decomposable explosive, and this investigation will throw light on the velocity of decomposition of mixed explosives.

ONE CHEMICAL CHANGE WILL EITHER PROMOTE OR INDUCE ANOTHER CHANGE OF THE SAME NATURE.

Farmer (*Jour. Chem. Soc.*, 1920, 117, 1603, 1432) has recently shown that the velocity of decomposition of high explosives becomes greater in presence of another explosive which is more readily decomposed. As far as our experiments go, we are inclined to the view that one chemical change will either promote or induce another chemical change of the same nature.

MECHANISM OF CHEMICAL CHANGE.

Being occupied so far with the question of acceleration and retardation of the velocity of chemical reactions, it would not be out of place to say a few words about the velocity itself. Within the last few years, a great deal of theoretical work in this direction has been done, notably by Perrin and Lewis. In a recent article (*Ann. Phys.* 1919 (9) 11, 5) Perrin shows that Arrhenius' equation for reaction velocity and temperature can be derived from the Planck or Wien radiation law on the assumption that the chemical action depends on the absorption of a nearly monochromatic radiation.

RADIATION IS THE MOTIF OF ALL CHEMICAL CHANGES.

In other words, these investigators postulate that radiation is the entire *Motif* of all chemical reactions, as well as of radio-

From our experimental work (*Proc. K. Akad. Wetensk. Amster.*, 1920, 23, 308) it has been shown that radiation is an essential factor in a chemical change, although the hypothesis of Perrin is still of a qualitative nature. Recently, Langmuir criticised adversely this hypothesis. Simultaneously with Langmuir, Lindemann published a paper (*Phil. Mag.*, Nov., 1920), in which he proved that according to Lewis' radiation hypothesis of the velocity of chemical reactions, the rate of cane sugar inversion in the presence of hydrochloric acid should be about 10-13 times greater in sunlight than in the dark. He adds, "yet the reaction proceeds at appreciably the same rate whether exposed to sunlight or not." Our experiments do not corroborate the above conclusion. We have found that a solution of cane sugar can be completely converted into a mixture of invert sugars at the ordinary temperature by exposing it to tropical sunlight, even in absence of acids, and the inversion of cane sugar in the presence of hydrochloric acid is markedly accelerated by sunlight (compare Dhar, *Zeit. Anorg. Chem.*, 1921).

It should now be emphasised that there is no fundamental difference between the mechanism of photochemical and thermal reactions. In a photochemical reaction the radiating body is not in thermal equilibrium with the reacting substance as it is in a thermal reaction, and the distribution of energy amongst the different frequencies does not necessarily follow Planck's distribution law.

From the foregoing pages, it is clear tha there are a lot of theoretical and experi mental evidence, more of a qualitativ nature than quantitative, in support of th radiation hypothesis which seeks to estab lish a connection between chemica changes (thermal, photochemical and cata lytic) and radiation. Hence, instead o discarding the radiation hypothesis w should try to bring fresh evidence, bot theoretical and experimental, in support c the hypothesis, and try to make it mor quantitative.

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NOTICES OF BOOKS.

Dyes Classified by Intermediates, by R. NORRIS SHOEVE. New York: The Chemical Catalog Co., Inc., 1922. Price $10.00 net.

This work aims at showing the relative importance of the various intermediates used in the manufacture of synthetic dyestuffs. The plan adopted has been to arrange the intermediates in alphabetical order, then to give some information about them, such as the methods of formation, references to the literature, and statistics to indicate their importance in the United States of America, and, finally, to give similar information (in the form of tables) relating to the various dyes derived from them.

The majority of the more important intermediates have been included, but the omission of such important alkylating agents, as dimethyl sulphate and ethyl chloride, has been noticed. A good point has been made by drawing attention to the advantage of using the empirical formula for reference purposes, and to enable this method to be employed, a very useful "Formula Index of Intermediates" has been given near the end of the volume. The synonymous names of the intermediates have been included in the alphabetical arrangement.

The short description of the "methods of formation" of the intermediates aims at giving the usual commercial method of preparation. Unfortunately, the method given is not always the correct one. This applies to that given for the preparation of benzene and toluene sulphonyl chlorides, where one would expect to find the chlor sulphonic acid method given instead of that using phosphorus pentachloride.

The references to the literature are poor, and as a rule simply refer one to some standard work on the subject, such as J. C. Cain's "Manufacture of Intermediate products for Dyes," or Lange's "Die Zwischinprodukte der Teerfarbenfabrikation," where one would naturally expect to find the subject mentioned without the author's direction.

The several different names which have been given to the same dyestuff by the various manufacturers, render the selection of a representative name a difficult matter. However, having made a choice, it would be reasonable to expect the name chosen to do duty throughout the book, but the author selects the names "Magenta" and "Fuchsine" and then refers to the same dyestuff as "Rosaniline" when dealing with the soluble blues, and omits the name Rosaniline from his "Glossary of Dye Names" altogether.

The weakest point of the whole work, and, unfortunately, it is the one which ought to be the strongest if the book is to serve the purpose for which it was written, is in connection with the statistical data. As every dye chemist knows, it is often possible to obtain the same day by more than one synthetical process (involving the use of different intermediates), and, as a rule, one is a commercial method, whilst the others are of purely academic interest, yet the author gives the same statistics under the intermediates not used as under those that actually are, without any indication that he is conscious of the fact.

The work as a whole is disappointing, but as it is the first attempt to treat the subject from this viewpoint, it is to be hoped that another attempt on similar lines will that another effort on similar lines will be made in the near future.

Chemistry for Beginners and Schools, by C. T. KINGZETT, F.I.C., F.C.S. Fourth edition; pp. V.I. + 237. London: Baillière, Tindall & Cox, 8, Henrietta St., Covent Garden, 1922. Price 5s. net.

Mr. Kingzett rightly points out that our future commercial prosperity depends upon our greater cultivation of science. Every boy should have an opportunity to acquire an elementary knowledge of chemistry and physics.

This little book is intended for the use of beginners, especially boys.

Whilst much of the matter is very good, the book is rather too full of facts for beginners. Thus, Part III. is largely an alphabetical catalogue of the elements (including rare earth and noble metals) and their chief compounds.

Chemical apparatus and the details of experiments are dealt with separately (Part IV.), also alphabetically. Finally, the extensive glossary (Part V.) serves also as an index.

The most important alteration in this edition is the enlargement of the glossary.

That the book has so quickly reached a fourth edition is sufficient to indicate its popularity. J. G. F. D.

New Patents.

This list is specially compiled for *Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

18758—Freeth, F. A.—Production of ammonium chloride and sodium carbonate. July 8.

18460—Guggenheim Bros.—Leaching caliche and recovery of nitrate therefrom. July 5.

18712—Petroff, G.—Production of phenol formaldehyde condensation products. July 7.

18713—Petroff, G.—Production of phenol aldehyde condensation products. July 7.

18804—Scottish Dyes, Ltd.—Manufacture of dyestuff intermediates. July 8.

Specifications Published This Week.

155592—Nitrogen Corporation. — Synthesis of ammonia.

181775—Dutt, E. E., and Dutt, P. C.—Process for the preparation of titanium dioxide from bauxite.

181835—Bloxam, A. G.—Manufacture of liquid esters of phosphoric acid.

181837—Pearson, R. E., Craig, E. N., and Durelco, Ltd.—Reduction of oxides of tungsten and molybdenum.

181884—Ebbw Vale Steel, Iron and Coal Co., Ltd., and Thickins, D.—Manufacture of dry neutral sulphate of ammonia.

163323—Nitrogen Corporation.—Preparation of hydrogen and ammonia.

Abstract Published This Week.

179982—*Sodium ferrocyanide*—Delaroziere, F. F., 22, Avenue Jean Jaures, Gentilly, Siene, France.

Sodium ferrocyanide is produced by adding sodium sulphate to a solution of calcium ferrocyanide and separating the calcium sulphate. Alternatively insufficient sodium sulphate may be employed to react with all the calcium, and, after separation of the calcium sulphate, the remainder of the calcium may be precipitated by the requisite quantity or slight excess of sodium carbonate. Crude salt-cake containing some sodium chloride may be employed, or sodium chloride be added to cause a greater separation of sodium ferrocyanide.

Messrs. Rayner & Co. will obtain printed copies of the published specifications, and forward on post free for the official price of 1s. each.

UNIVERSITY OF BIRMINGHAM.

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Medicine: All subjects leading to Degrees and Diplomas in Medicine and Dentistry.

Commerce: Subjects leading to Degrees in Commerce.

Department of Training for Teachers:
Department of Social Study:

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THE SESSION 1922-23 COMMENCES ON OCTOBER 2nd, 1922.

ALL COURSES AND DEGREES ARE OPEN TO BOTH MEN AND WOMEN STUDENTS.

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and will be sent on application to th Registrar.

THE CHEMICAL NEWS,

VOL. CXXV., No. 3252

Shall German Brains Beat British?

BY LORD BIRKENHEAD,

LORD HIGH CHANCELLOR OF GREAT BRITAIN.

It has been said, with more point than politeness, that statistics never lie unless the statistician is a liar. I want to begin, notwithstanding this forbidding epigram, with some statistics which tell their own tale so plainly that no one can misunderstand or misuse them. I am not responsible for the figures, for I take them from official Blue-hooks.

To hegin with, here are the values of the chemicals imported into this country during the years 1913-1919:—

Years.	£
1913	4,534,536
1914	4,180,400
1915	7,493,134
1916	12,268,439
1917	14,178,139
1918	25,623,731
1919	7,248,780

Side by side with the above statistical story of our country's need for chemicals during the great war, another and very different story remains to be told, also in statistics. The following table gives the annual value of the exports of chemicals from Germany in the period preceding the war:—

Years.	£
1901	20,418,300
1902	21,520,500
1903	22,412,200
1904	23,674,900
1905	27,117,000
1906	29,510,200
1907	29,422,500
1908	27,702,800
1909	31,226,300
1910	35,551,000
1911	38,573,500
1912	41,923,500

The contrast is very striking. These statistics show us that in the period preceding the war Germany was making giant strides in the chemical industry. They are the statistical reflection of the fact, known to everyone, that in this industry she was the first and the rest of the world nowhere.

OUR HANDICAP.

Now, there are some people who can derive comfort from the pious faith that the pre-war position of the chemical industries is an excellent illustration of the great advantages that flow from what they call the "international division of labour."

Nature, they say, marks out certain territorial areas as suited for one industry and not suited at all, or much less suited, for another. They go on to argue that what Nature does in extreme cases man rightly proceeds to do in other cases not so extreme. Man places the chief seat of the heavy chemical trades in the United Kingdom and the chief seat of the fine chemical trades in Germany. It works out for the advantage of everybody. We specialise in one thing and the Germans in another; and so we mutually supplement and round off our activities to the great advantage not only of ourselves but of the whole world. I agree, with a limitation. This harmonious theory of the territorial division of labour between one race of men and another supposes that men do nothing but work and trade. Unfortunately, they sometimes fight. They began to fight on August 1, 1914, and before many months had gone by it was discovered that the territorial division of the chemical industries between ourselves and Germany, even if it had been an advantage to us during peace, had at once become a definite disadvantage on the outbreak of war.

The plain truth is that it might have led to our defeat but for the fact that we set to work to draw raw materials from all parts of the world, and to manufacture for ourselves the essential chemicals of war of which Germany had had a practical monopoly.

Every man with a single grain of common sense fervently hopes that the great war taught the world that there should be no more war. But it is one thing to hate war and to hope that there will be no more war, and quite another thing to act on the suppositiou that there will be one. Hate and loathe war as he may, the patriot

statesman has got to reckon with the fact that the past history of the world is full of wars, and that whatever his hopes may be, he must act on the supposition that war has not come to an end.

And, judging from the history of the last war, those who have the right because they have the knowledge, to demand that we should listen to them, tell us without hesitation that chemistry will play a greater part in the next war than it did in the last. It is not merely a question of poison gas, the use of which the Germans introduced, to their subsequent great regret. Chemistry is closely concerned with the manufacture of those instruments of war, the use of which is perfectly legitimate. The best gun and the best explosive will fall in the long run to the nation with the best chemicals.

THEIR ADVANTAGE.

During the war we improvised a fine chemical industry, which enabled us to carry on and pull through. But, naturally enough, the reopening of trade between Germany and the rest of the world, including ourselves, brings us face to face with this question: How are we to make sure that in the matter of chemicals no subsequent experience, whatever it be, shall find us once again, as in August, 1914, at a complete disadvantage in relation to Germany? For, so far as these trades are concerned, Germany begins the peace with almost the same superabundance of advantages with which she began the war. If, on the one hand, the workers in her chemical trades are now slovenly and slack in comparison with pre-war days, the exigencies of war drove German chemists to make discoveries of very great importance.

I have no technical knowledge on these points, but I read, for example, that she successfully made synthetic rubber, and that she was also successful in turning her lignite, or brown coal as it is commonly called, into oil; and it requires no technical knowledge to be able to argue that if she succeeds by further effort in doing these things on a commercial scale and on commercial terms, she has worked two miracles which will give her a tremendous advantage in the industries of peace.

We cannot rob them of these advantages, and we do not propose to try. What we must do is to follow suit.

At bottom the question is: Shall German brains beat British brains? And here I want to point a very obvious moral. Not only do our extremists constantly talk as if, from the economic point of view, the only kind of labour that counted was manual labour, but our Labour leaders, who surely know better, disparage all the higher sorts of labour, inventive and directive, by constantly ignoring them on the platform—a considered piece of propaganda for which the cautious praise of Mr. Sidney Webb, in his innumerable and unending books, pamphlets, leaflets, and memoranda, is no real counterpoise. The most important kind of labour in this or any other country is brain labour.

I am at a disadvantage in one respect because Germany has never been, and never, I imagine, will be, my spiritual home. The deficiency, however, does not prevent me from discerning a very important difference between the two brains, German and British. It was a British chemist, Perkin, who discovered that dyes could be made from coal tar. It was German chemists who made them and refined on them in such a way that the British textile trades became absolutely dependent on German dyes.

The British brain works best upon special lines of its own. Think of two men, quite unknown to each other, Darwin and Wallace, simultaneously working out the great doctrine of evolution. In a word, the individualism which is the root characteristic of the Englishman, applies not only to his conduct and to his creed, but affects the whole of his mental processes. I profoundly believe that in the war that was a great advantage. The self-reliance of Englishmen, their capacity to think, reason, and act for themselves were of untold advantage in the trenches.

But note another thing. At home, in order to win the war, we had to imitate the Germans in one important respect. *We had to do our brain work in teams.* Our scientists had to do their researching as an organised body. Someone had to dictate the ends to be sought and to suggest the methods to be adopted. We won the war by pooling not only our energy but our minds.

Now, this is precisely how the German chemists built up their giant industry. In June, 1919, the Association of British Chemical Manufacturers sent a highly qualified mission into the occupied territories of Germany to examine things on the spot. It is clear that the mission came

back deeply impressed by what they had seen.

TRAINING FOR THE FUTURE.

They had made up their minds that German success in the chemical industry was thoroughly deserved because it had been won by honest labour. Whose labour? The great organisers of industry—the men who stand at the head of such gigantic firms as Bayer and Company and Lucius and Bruening deserve their full share of praise. Probably when they banded themselves into the "I.G."—a combine of all the great firms—they may have lost in initiative what they gained in efficiency. That is a matter on which no one can dogmaise. But at bottom the labour which built up the German chemical industry was the labour of chemists.

In Germany the trained chemist has come to occupy a position in society strictly analogous to that occupied in this country by the lawyer or the clergyman. Chemistry in Germany is a liberal profession, and chemists of the highest quality abound.

Though I have been writing throughout of one industry only, it is obvious enough that I have had industry as a whole in view. The manufacturers of this country have got to make up their minds on one point. They must either train and use brains plentifully and bountifully, or fall behind in the race for industrial success.

The workshop and the university must be linked together. The laboratory and the library are as essential elements of business success as the costing department and the counting house. The twins of trade henceforth are the great organiser and the great scientist.

[Reprinted by courtesy of the "Weekly Dispatch."]

THE DETERMINATION OF CULTURED PEARLS.

By Cyril S. Fox.

In the author's paper, "Notes on Indian Precious Stones," published in August, 1921, in the *Journal of Indian Industries and Labour*, Vol. 1, Part 3, p. 325, the question of "cultured" pearls was dealt with in a general sort of way. It was there assumed that the nucleus of the cultured pearl was of exceedingly minute dimensions, and attention was called to the fact that experienced pearl merchants and certain zoologists could distinguish, by little differences of colour and sheen, pearls from various countries, *e.g.*, Japan, Australia, Ceylon, etc., but that when it came to a question of distingnishing natural pearls from cultured pearls of the same locality[1] there was no present method, other than by cutting the pearl in half, of telling the one from the other. Subsequent tests by prominent pearl dealers and others have only confirmed the above statement in respect of *Japanese* natural and cultured pearls.

Dr. Herbert Smith, of the Natural History Museum, London, working in collaboration with Messrs. E. Hopkins,[2] of St. *Andrew's House, 32/34, Holborn Viaduct*, who supplied the material for experiment and made valuable suggestions, has examined many varieties of pearls in ultra violet light (as developed by the electric arc and mercury vapour lamp of the type in use by many jewellers dealing in pearls).

These workers find that practically all pearls from the Persian Gulf, generally known as Indian (and which comprise 90 per cent. of the pearls from the East), can be distinguished immediately from Japanese pearls, both natural and cultured, and from certain pearls from Australian waters.

The differences which the writer saw, in the specimens shown to him, between natural pearls and the trade Japanese cultured pearls, when examined in ultra violet light, were obvious. The natural pearl, though fluorescent, is opaque in ultra violet light, whereas the Japanese type of pearl has a distinct translucent opalescence, and it does not require the services of an expert to see the difference.

A number of facts have been collected during recent investigations to show that the substance of the mother-of-pearl and pearl of the Japanese oyster is in a slightly different condition to that forming the shells and pearls of oysters from Indian (Persian Gulf) localities. Thin sections of the mother-of-pearl of the Australian oyster and Japanese pearls show the lamination and concentric growth very delicately

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1 *So far as is known, pearls are only being cultured in Japan.*

2 *This progressive firm has now established a small mercury vapour lamp in its offices, and can carry out tests in a few minutes.*

—the appearance being like that of pale polished agate. The calcium carbonate would appear to be in a crypto-crystalline, possibly hydrous, condition. The lamination and concentric growths of most other pearls, show up far more boldly in microscope sections, and this is evidently due to a better developed, fine grained, crystalline structure. Although there is a distinct difference in structure between marine and fresh water pearls, the Japanese type of pearl can always be distinguished. In each case, however, anomalous dispersion is observed between crossed nicols.

There is one point, however, in which scientists have not always seen the question of cultured pearls with the eyes of responsible pearl dealers. These merchants are the custodians of the public confidence in matters of jewellery, and take a great pride in the reputation they enjoy, and deserve, for straight dealing. They claim that, in most cases, the cultured pearl is an inferior article to the natural pearl. The difference between the two is evident from the sections of cultured pearls so far examined under the microscope. The natural pearl is concentric in structure from the centre to the surface—it is practically wholly a pearl. The cultured pearl is not, as it usually contains a large nucleus. If the cultured pearl contained so small a nucleus that the weight of this nucleus was an insignificant part of the final pearl there would be little cause for dismay, but when it is found that in some cases the volume of the nucleus of mother-of-pearl in the cultured pearl ranges from half to nine-tenths of the bulk of the pearl the matter assumes quite another aspect, and merges on the border line of imitation pearls.

The public do not want to pay the same value for a bead, most of which is cheap nucleus. This is what pearl dealers also wish to avoid, and they have been striving to safeguard their clients. They do not wish to be associated in their dealings in natural pearls with ornaments which are not wholly pearls. They have been faced with the difficulty of distinguishing the natural from the cultured pearl. As it happens, this difficulty at present only concerns the Japanese type of pearls, which are easily distinguished in ultra violet light from other types of pearls. The Japanese natural pearl, as such, evidently appears to be unknown in the trade, and the "cultured Japanese pearl" has a characteristic greenish yellow tint in natural light. The Japanese pearl has usually been considered as inferior to other pearls owing to its colour. Consequently, the safest line of action appears to many dealers to be to class all the Japanese type of pearls, cultured and so-called natural, in one category, and to treat them as a less valuable type of pearl than the natural pearl of other countries. This line of action is natural enough, although it will obviously penalise any existing natural Japanese pearl, as well as the cultured Japanese pearl which may have a very minute nucleus (as a result of experience all cultured pearls appear to have a proportionately large nucleus); but, on the other hand, the trade must protect itself against cultured pearls with large nuclei and little true pearl formation until such time as an accurate determination is possible regarding the sizes of the nuclei.[1]

1 *By examining a drilled cultured pearl with a powerful magnifying glass the junction of mother-of-pearl can frequently be seen.*

CYRIL S. FOX.

(*Journal of Indian Industries and Labour.*)

TAKING REFRACTIVE INDICES OF LIQUIDS.

BY ROBERT FOURACRE, PH.C.

(*Abstract.*)

(*With acknowledgments to the "Chemist and Druggist."*)

In the following simple method of obtaining the refractive indices of liquids by placing a small quantity between a convex lens and a piece of plane glass or mirror, thus forming a liquid lens, the reading is made by means of a real image, the distance of object being constant. The new principle embodied consists in employing a small electric bulb (as used in pocket torches) for the object, and placing it at the focal distance of a convex lens so that light passing through it is parallel. This beam is then projected through the combination of a convex lens laid on a glass plate with the liquid to be examined between the two (in the usual manner). By moving the combination, the light is then brought to a focus on a plane surface, the correct distance being determined by the sharpness of the filaments. The distance between the

surface of the liquid (*i.e.*, the upper surface of the glass plate) and the image will be the focal length. This reading divided into the known focal length of the lens use din the combination, and the result substracted from 2 will give μ of the liquid. The explanation is the focal length of a lens being the reciprocal of the sum of the reciprocals of distance of object and image, when the object is at the focal distance the image will be at infinity, that is, the rays of light will be parallel. So that light falling on the combination will be parallel, and therefore the distance of the object will be at infinity no matter what distance it may be from the combinatiou of the latter from the image. This distance will be the focal length of the combination, and by subtracting the power of the known lens from the power of the combination, the focal length of liquid lens can be obtained, and from this, μ of liquid lens by means of formula: $f = \frac{\gamma}{\mu - 1}$ Radius (γ) of liquid lens being the same as the surface of the lens with which it is in contact, and if lens of crown glass (μ 1.5) is used then (r) will equal focal length. A lens of 20 cm. length is a convenient one to use for μ from 1 to 1.6.

Thus:—if d = observed distance, x = power of liquid lens (in dioptres), f = focal length of liquid lens, μ = refractive index of liquid lens, and lens of 20 cm. (5 dioptres) being used, r will equal 20.

(1) $\frac{100}{20} - \frac{100}{d} = x$ (2) $\frac{100}{x.} = f$;

then from the formula $f = \frac{r}{\mu - 1}$ $f = \frac{20}{\mu - 1}$

Substituting (2) for f, $\frac{100}{x} = \frac{r}{\mu - 1}$

Again, substituting (1) for x, the following is obtained:

$$\frac{100}{\frac{100}{20} - \frac{100}{d}} = \frac{r}{\mu - 1}$$

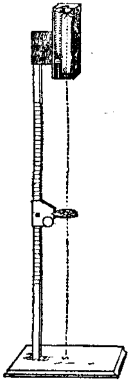
$$100\ (\mu - 1) = 20 \left(\frac{100}{20} - \frac{100}{d} \right),$$

$$100\ \mu - 100 = 100 - \frac{2.000}{d}$$

$$100\ \mu = 200 - \frac{2,000}{d}$$

$$\mu = 2 - \frac{20}{r}$$

After describing the original experiments, the author said that the apparatus consists of a brass rod, 30 in. long, fixed to a stand at the bottom and having a rack on one edge starting approximately 20 cm. from the base and going up to 40 cm. At the top of the rod a frame is fitted on, which holds the electric bulb and a pocket battery. To save current the lamp is connected by a piece of spring brass which acts as a switch. On the rod itself, and working on the rack by means of a piston with knob, is the travelling platform having a hole in the centre, on which is laid the glass plate (a microscopic slide) and lens. A piece of white paper is laid on the stand to receive the image for focussing purposes. The electric bulb and two lenses must be in alignment. One side of the rod is marked in c.m. from 20 to 60, but should also be divided into m.m. Both lenses used are ordinary plus 5 spectacle lenses. In cases where μ is greater than 1.6, a lens of higher power can be substituted in the combination. All calculations other than corrections for temperature can be eliminated by use of a table or a graph. For example, with a lens of 20 c.m., there is a gradual decrease from 0.047 at 20 c.m. to 0.006 at 60 c.m.



Distance in c.m.	Refractive index.	Distance.	Index.
20	1.000	41	1.512
21	1.047	42	1.5238
22	1.09	43	1.534
23	1.13	44	1.5454
24	1.16	45	1.5555
25	1.2	46	1.565
26	1.23	47	1.5745
27	1.26	48	1.583
28	1.285	49	1.5918
29	1.31	50	1.6
30	1.333	51	1.607

The temperature of the liquid can be adjusted by placing the glass plate and lens into water of the temperature required for a few minutes before use. One drop of the liquid, or at most two, is required for the plat-reading. It is better to start with the plat-form at the top and gradually lower it. The apparatus can easily be extemporised, and the calculation required is reduced to a minimum.

ALUMINA.

Hydrolysis of Aluminum Salts.

By Wilder D. Bancroft.

(From the Journal of Physical Chemistry, June, 1922.)

(Continued from Page 57.)

Knecht [1] comments on these data as follows: "It is a prevalent opinion that when wool is boiled with aluminum sulphate, for instance, the salt is decomposed by the fibre in such a manner that aluminium hydrate and sulphuric acid are formed, of which the former is assimilated by the fibre, while the latter remains in solution. Others again assume that an insoluble basic sulphate of alumina is formed on or in the fibre. Quantitative determinations, carried out by Fürstenhagen and Appleyard, show that when wool is boiled with a solution of alum no free acid remains in solution when the amount of alum does not exceed five per cent. of the weight of the wool. When larger amounts are used, a basic sulphate of alumina is fixed on the fibre. Now it has always been shown that wool possesses a considerable affinity for both acids and bases, and, in its whole behaviour it evidences the properties of an amido acid—that is a substance possessing simultaneously basic and acid properties. This would explain in a satisfactory manner the fixation of both the acid and basic constituents of the alum, but in what form these are fixed still remains a matter of conjecture. It is not improbable that the phenomenon is due to actual chemical combination with the fibre or with certain constituents of the latter; just as lead or mercury, when absorbed by the system, enters into chemical combination with the albuminoids in the various organs. That a hydrate is not formed is conclusively shown in mordanting wool with copper salts. The fibre assumes a green colour; but copper oxide, when boiled, is at once dehydrated and transformed into black copper oxide. If copper hydrate had been formed, the fibre would be black, whereas it is green, and remains so even after prolonged boiling."

It has already been shown that F[illegible]rsten-hagen and Appleyard have not proved by quantitative determinations that a basic sulphate of alumina is fixed on the fibre. They have proved that both alumina and sulphuric acid are taken up by the fibre; but nothing more. Knecht seems to real-ise this unconsciously, because he himself admits that it remains a matter of conjec-ture in what form the acid and basic con-stituents of the alum are fixed. That is true; but that is quite a different thing from showing that a basic aluminum sul-phate is fixed on the fibre. Knecht's argu-ment in regard to the copper hydrate is fal-lacious because hydrous copper oxide does not necessarily turn black when heated to 100°. Tommasi[1] showed that when a little hydrous manganous oxide is precipitated with the hydrous copper oxide, the latter does not turn black when boiled. Blucher and Farnau[2] found that a similar stabilisation of the blue colour could be obtained by adding hydrous oxides of nickel, cobalt aluminium, chromium, and magnesium. With zinc there was some stabilisation, but practically none with mercury. If the blue colour is due to the state of sub-division of the copper oxide, anything which will prevent it from agglomerating will keep i

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[illegible] Knecht, Rawson and Loewenthal: "A

1 *Bull. Soc. chim. Paris*, [2] 37, 1 (1882); *Comptes rendus*, 99, 37 (1884).

2 *Jour. Phys. Chem.*, 18, 629 (1914).

blue. Schenck[1] has shown that a mixture of the oxides of copper and alumina containing about five per cent. copper oxide can be heated in a blast lamp without turning black. Owing to the lower copper content the colour is a light greyish blue. With ten per cent. copper oxide, the blue colour was deeper and withstood heating in a Bunsen burner, but showed signs of turning black when heated in the blast lamp. During the winter of 1920-21 Mr. R. K. Parsell repeated Mr. Schenck's experiments and, after heating, dissolved out as much alumina with caustic soda as he could get without getting any blackening. In this way he was able to get a powder which was a beautiful deep blue and which contained approximately seventy-five per cent. cupric oxide and twenty-five per cent. alumina. If one insisted on writing a formula for this, it would be approximately $(CuO)_4\ Al_2O_3$, which is rather absurd. There are not only no indications of a definite chemical compound; but, after standing for a year the powder has changed from blue to green. We do not know whether it will go black in time or not.

According to Havrez[2] and to von Georgievics[3] the amount of sulphuric acid taken up by wool from an aluminum sulphate or an alum bath increases relatively to the wool at high concentrations until at twenty-four per cent. alum referred to the wool, the alumina and the sulphuric acid are taken up in the same relative amounts as they occur in aluminum sulphate. At higher temperatures, relatively more sulphuric acid is taken up. I have never seen the original data and the abstracts are confusing and to some extent contradictory. Havrez[4] claims that with high alum concentration, the peptizing action of the alum on the alumina is so great that less alum is taken up than at lower concentrations. If this is true, the amount of alumina adsorbed passes through a maximum. On the other hand he apparently based his conclusion on the fact that wool mordanted in concentrated alum solutions did not dye to so deep a shade and this may be an effect of the sulphate taken up. Leichti and Hummel, however, "disagree with his assertion that an excess of alum acts like an acid which dissolves the alumina." Dreaper[1] who gets Havrez's name wrong, says that "Harvey pointed out in 1872 that in the case of very concentrated solutions of alum, more sulphuric acid than alumina is absorbed. This has been recently confirmed by von Georgievics. It appears that with a 24 per cent. solution of alum [referred to wool], and a proportion of water fibre of 30:1 alumina and sulphuric acid are taken up in their normal proportions. The affinity of wool for acid is stronger in dilute solutions and stronger for the alumina in strong solutions. The relative curves cross each other at 24 per cent." There must be a misprint in the next to last sentence of this quotation, the words acid and alumina being transposed.

Havrez[2] states, and Liechti and Hummel confirm him, that addition of acid (presumably sulphuric acid)[3] is beneficial with such low concentrations of alum as one per cent. on the wool. Since all the alumina is taken up at these concentrations, the object of adding the acid cannot be to increase the adsorption. The statement is made that with low concentration of alum the bath becomes alkaline, in which case the acid is added to counteract this. It is not clear whether the alkalinity is due to lime in the wool reacting with sulphuric acid, to ammonia going out from the wool, or to a partial adsorption of sulphuric acid from the potassium sulphate of the alum. This last hypothesis could be tested by running similar experiments with aluminium sulphate. Liechti and Suida[4] state that alum is not quite as good a mordant as aluminum sulphate, though the difference is not marked. This may seem to contradict their alleged previous statement that sodium sulphate increases the hydrolysis of aluminum sulphate on boiling; but the contradiction disappears if we postulate, which seems reasonable, that the sodium sulphate, though increasing the hydrolysis of the aluminum sulphate, also increases the relative amount of sulphuric acid taken up by the

1 *Ibid.*, 23, 283 (1917).

2 *Chem. Centralbl.*, 1874, 696; *Cf. Liechti and Hummel*: *Jour. Soc. Chem. Ind.*, 13, 226.

3 *Jour. Soc. Chem. Ind.*, 14, 653 (1895).

4 *Jour. Chem. Soc.*, 26, 206 (1873).

1 "*The Chemistry and Physics of Dyeing*," 62 (1906).

2 *Jour. Soc. Chem. Ind.*, 13, 226 (1894).

3 *Cf. Knecht, Rawson and Loewenthal*: "*A Manual of Dyeing*," 237 (1910).

4 *Jour. Soc. Chem. Ind.*, 5, 526 (1886).

wool. The first would be beneficial and the second harmful, and we do not know to what extent the two balance, or even whether this is the true explanation.

One objection to alum or aluminum sulphate as a mordant is that the sulphate coagulates the hydrolyzed salt so readily that very perceptible amounts of alumina or of basic salt are precipitated in the bath or on the wool in such a form that it rubs off. It seems as though this could be got round by heating the solutions more slowly. A simpler method of getting round this difficulty is to use aluminum salts of organic acids, which hydrolyze more readily than the sulphate because the acids are weaker, and yet which keep the colloidal alumina peptized in a finer form.

Adsorption of Aluminum Tartrate, Etc., by Wool.

This was done more than a century ago by adding tartar (acid potassium tartrate) to a solution of alum.[1] "To impregnate wool or woollen cloth with the aluminous basis, it is commonly boiled in water, with from one-fourth to one-sixth of its weight of alum, and from one twelfth to one-sixteenth of its weight of crude tartar, putting the latter first into the water, and, afterwards, the powdered alum: the heat of the water being gradually raised, is kept at the boiling point for an hour and a half, or two hours, during which the cloth is turned through the boiling liquor on a winch, that the mordant may be equally applied; and being afterwards taken out and drained, it is commonly left until the next day, and then rinsed in clean water, for dyeing. In the early collection of recipes, printed in 1605, and already mentioned, sour bran liquor is commonly directed to be employed in this way with alum; and it seems to have answered the purpose of tartar, which, when it came to be generally used in this way with alum; was supposed by the older dyers to do good by softening and correcting the acrimony of the latter: probably, however, the purposes which it answers, are not yet clearly ascertained; one of them seems to be that of increasing the solubility of alum, and enabling it more completely and intimately to penetrate the fibres of the wool, with which it moreover enters into a permanent union, and thereby contributes efficaciously to modify, vary, and in some cases to brighten the colours with which it is employed, as will be seen hereafter."

1 [illegible] "*Philosophy of Permanent*

Liechti and Suida[1] have studied the behaviour of aluminum tartrate. Starting with an amount equivalent to eight per cent. aluminum sulphate, $Al_2(SO_4)_3.18H_2O$, referring to the wool, the whole of the alumina was fixed firmly on the wool. On treating the wool with hot water, the wash water became acid, showing that some tartaric acid was also taken up. The normal tartrate can be replaced without detriment by a mixture of one molecular weight of aluminum sulphate with 1.5-3.0 molecular weights of cream of tartar. If the normal tartrate is prepared by double decomposition, using the normal potassium sodium tartrate (Rochelle or Seignette salt) according to the equation,

$$2Al_2(SO_4)_3 + 6KNaC_4H_4O = 2Al_2(C_4H_4O_6)_3 + 3K_2SO_4 + 3Na_2SO_4$$

the results were not as good as those obtained with the pure tartrate or with alum and tartar, in which latter case the bath contains some acid potassium sulphate in addition to the aluminum tartrate. "Since the general practical experience of dyers is that wool is better mordanted in an acid bath, it was thought possible, perchance, to replace the cream of tartar by an acid, sulphuric acid, for instance. Experiment showed, however, that although a small addition of sulphuric acid (1 mol) increases slightly the amount of alumina absorbed by the fibre, it cannot replace the cream of tartar. Since the addition of a larger amount of sulphuric acid (3 mols) yields very unsatisfactory colours although it hinders the dissociation of the mordant solution, it is evident that the beneficial action of the cream of tartar cannot be ascribed merely to its retarding the dissociation of the mordant." The explanation undoubtedly is that the use of tartrate cuts down the degree of adsorption of the sulphuric acid.

1 *Mitt. techn. Gewerbe-Museums in Wien, Sektion für Färberei*, 3, 48 (1886); *Jour. Soc. Chem. Ind.*, 4, 526 (1886); *Knecht, Rawson and Loewenthal*: "*A Manual of Dyeing*," 237 (1910).

(To be Continued.)

BASIC SLAG.—THE CHANGE IN ITS COMPOSITION.

REPORT BY CHAS. F. JURITZ, M.A., D.Sc., F.I.C., CHIEF, DIVISION OF CHEMISTRY.

(From the Journal of the Department of Agriculture, July, 1922.)

A considerable change has come over the composition of basic slag since the war, whereby its grade has been lowered. The subject has been given serious attention in England, and the Imperial Minister of Agriculture in July, 1920, appointed a committee to study the basic slag problem, with Dr. E. J. Russell, the Director of the Rothamsted Experimental Station, as chairman. Towards the close of 1921 this committee submitted an interim report, which has not yet been published.

The change of composition is due to the fact that in the steel industry the basic Bessemer process, of which basic slag was a by-product, has now been superseded by the basic open-hearth process, and the character of the by-product has been entirely altered, its phosphate content having been halved.

INVESTIGATIONS IN ENGLAND.

The terms of reference placed before the Departmental Committee, which comprised steelmakers, fertilizer manufacturers, and farmers, were "to consider the development and improvement of the manufacture of basic slag and the extension of its use." The committee has up to the present discussed such questions as these: (1) the quantity of slag producible under present conditions; (2) how much slag can be advantageously utilised by farmers in Britain; (3) how the quantity or quality of the slag may be increased by combining with the ordinary manufacture of steel some subsidiary process; (4) what the agricultural value of the present quality of slag is.

(1) Before the war the annual output of high-grade slag in Britain was 260,000 tons. In 1920 it was only 46,000 tons. It may be of interest to tabulate the whole of the 1920 output according to grade:—

	tons.
Over 15 per cent. phosphoric oxide	46,000
12 per cent. and under 15 per cent.	121,000
10 per cent. and under 12 per cent.	91,000
7 per cent. and under 10 per cent.	302,000
5 per cent. and under 7 per cent.	118,000
Under 5 per cent.	23,000
Total	701,000

In addition to the 46,000 tons of high-grade slag—and it will be remembered that, according to our own definition, high-grade slag must contain not 15 but 16 per cent. of citric-soluble phosphoric oxide, and in the above table not only the citric-soluble but *all* the phosphoric oxide is included—there was only 212,000 tons of lower-grade slag that would have been allowed on our market at all, even under our relaxed war-time regulation No. 11. This quantity would not even suffice the British farmer, and precludes all idea of export. As for the 23,000 tons below 5 per cent., it would not be worth grinding.

(2) As far as the second point discussed by the committee went, it was estimated that the farmers of the United Kingdom ought to have been using 890,000 tons of basic slag annually, even before the war.

(3) Regarding the augmentation of the phosphate in the slag from subsidiary sources (*a*) some experiments were carried on by adding rock phosphates in the proportion of ½ cwt. per ton of the slag in the fused state, but there was not sufficient alteration of the rock phosphate to justify the process, and the committee decided that such an addition could only be justified if it improved the character of the rock phosphate added. (*b*) The use of iron ore containing more phosphorus or the addition of phosphates in the blast furnace was considered, but from the steel manufacturer's point of view this would add to the cost of production of the steel, and could, therefore, be adopted only if the price of the resulting slag were sufficiently attractive. The matter is still under consideration. (*c*) Another point remaining under consideration is the reintroduction of the two lowest grades of slag into the blast furnace so as to increase the phosphatic character of the pig-iron, and thus produce a higher-grade slag.

(4) The committee arranged for experiments to be carried out at Rothamsted to elucidate—

(*a*) Whether the soluble and insoluble open-hearth slags differ in agricultural value, and, if so, whether some method of evaluation can be devised better than the present citric acid method;

(*b*) whether the present open-hearth slags are inferior to the pre-war Bessemer slags when applied in quantities of equal phosphatic content;

(c) whether finely ground mineral phosphates differ *greatly in value from* basic slag;

(d) whether the manurial effect of basic slag is *wholly dependent on its* phosphate content, or whether other constituents (manganese, etc.) should be considered of value.

Up to six months ago no conclusion had been arrived at on the first three of these points, and on the fourth the results lent no *support to the idea that manganese is of* value.

THE QUESTION OF SOLUBILITY.

In the January, 1922, issue of the Journal of the Ministry of Agriculture, Dr. E. J. Russell says that "in days before the war farmers were always urged to purchase only high soluble slag, and the grades sold by the best firms had a solubility of 80 per cent. and upwards. During the war the process of manufacture changed, and it is an open secret that the experts are no longer so much in agreement as they were *in regard to the desirability of a high* soluble slag. Experiments have been initiated to obtain more definite information, and until these are completed it is not possible to lay down precise rules for the farmers' guidance. In the meantime it is wise to assume that a high soluble slag will usually come into action more quickly than one of low solubility, and that a larger return may therefore be expected in the first season. *It is possible, however, that in* later seasons the low soluble slag may grow in effectiveness, and at the expiration of five years there may be little difference between the two: in some experiments, *e.g.*, in Essex, this is clearly demonstrated. Until more definite evidence is forthcoming, perhaps the *safest assumption the farmer can* make is that high-soluble slag may pay him interest on his outlay almost from the beginning, while the returns from low-soluble slag may be deferred."

By high-solubility and low-solubility in his quotation, it may be explained, is meant *the proportion of citric-soluble to* total phosphoric oxide in a slag, and not necessarily the high or low proportion of *soluble phosphoric oxide to the slag as a* whole.

In the Essex experiments comparative tests were made of the following two fertilizers:—

Class of Fertilizer.	Proportion of Citric-Soluble in Total Phosphoric Oxide.
Open-hearth basic slag	20 per cent.
High-grade basic slag	91 per cent.

The produce of two types of soil sown with clover resulted as follows:—

	Soil No. 1.		Soil No. 2.	
	Open-hearth Slag.	High-grade Slag.	Open-hearth Slag.	High-grade Slag.
	p.c.	p.c.	p.c.	p.c.
Clover ...	27	50	44	46
Grass ...	45	33	32	47
Weeds ...	16	14	14	1
Bare ...	12	3	11	5

Dr. Russell's comment on this was that "the crop returns show that high-grade slag is, as a matter of fact, rather better than low-grade, especially in improving the quality of the herbage. The difference is not so great as would be expected from the difference in solubility, and it seems clear that present-day analytical methods do not deal satisfactorily with present-day slags."

Such, then, is the position to-day. We have not yet come to the stage of finality *in the matter. It is true that general* buying conditions on the basis of 16.1 per cent. citric-soluble phosphoric oxide cannot now be reached, but then we do not ask for such a basis, even in our existing unrelaxed regulations—"12 per cent. of phosphoric oxide soluble in citric acid" is the minimum *limit laid down by* Regulation No. 11. On the other hand, it must be borne in mind that not only has the total percentage of phosphoric oxide in slag diminished, but even of that reduced total a much smaller proportion than before is soluble in citric acid.

Although, therefore, I think that the regulations need amendment,* it will never do to relax them to an extent that will permit of the unrestricted sale in this country

of material which may later on be shown to possess but the scantiest agricultural value.

The Temptation of Admixing.

There is another consequence of the altered quality of basic slags to which I wish to draw attention. The temptation to admix other phosphates has obviously become greater than it used to be, and quite recently the term "slag phosphate" has been applied in England to a mixture of basix slag and mineral phosphate which has appeared on the British market. Dr. Russell has issued a warning to farmers to be careful to realise exactly what these words stand for when they are used.

Mixtures such as these have not yet, as far as I know, made their appearance in South Africa, but doubtless they will not be long in coming, and in the meanwhile I may also draw attention to a note published in the *New Zealand Journal of Agriculture* about three months ago by the New Zealand Agricultural Chemist to the effect that phosphate rock from Nauro and Ocean Islands has been sold to a Welsh basic slag company for the purpose of grading up their slag, and that the British Ministry of Agriculture has recommended farmers to try this mixture of slag and phosphate rock on their grass lands, and to lay thereby a good foundation for arable land. Regarding this mixture, too, experiments are in progress, both in Great Britain and in New Zealand, and for the present it only lies with us to differentiate between it and true basic slag.

* *The Regulations were amended by Government Notice No.* 963 *of the* 14*th June*, 1922, *which provides that the minimum content in basic slag of phosphoric oxide soluble in citric acid shall be* 10 *per cent. instead of* 12 *per cent.*

THE ALTERED COMPOSITION OF BASIC SLAG.

(From the Journal of the Department of Agriculture, July, 1922.)

Basic slag, a by-product from the manufacture of steel, is a fertilizer rich in lime and phosphates, and large quantities are imported into the Union, as will be seen from the following table, which gives the importations in tons of 2,000 lb.:—

1913	5,970 tons.
1914	6,832 tons.
1915	9,027 tons.
1916	6,231 tons.
1917	636 tons.
1918	Nil.
1919	1,920 tons.
1920	5,120 tons.
1921	1,905 tons.

These quantities, however, are still far below what it is estimated the Union requires annually of this fertilizer, the conditions set up by the war and the high prices which followed being the cause of the decreased importations. Basic slag is being used chiefly for grain crops in the south-west districts of the Cape Province, the chief wheat-producing area of the Union, where it is a valuable fertilizer for sour soils: it is found useful also in maize growing in certain of the soils of the Transvaal, but it is not extensively employed for this purpose at present, for economic reasons.

Anything concerning an article of such importance in South African agriculture as basic slag (known also as Thomas' phosphate or Thomas' slag), will be of interest to farmers, and an article on the subject, written by Dr. Juritz, the Chief, Division of Chemistry, is published in this issue of the *Journal*. For since the war a considerable change has come over the composition of basic slag, owing to a new process being employed in steel manufacture, with the result that the character of the by-product has been entirely altered, its phosphate content having been halved. This, of course, affects the value of basic slag, and experiments are being carried out in England with a view, among other objects, to increasing the quality and quantity of slag produced by combining with the ordinary manufacture of steel some subsidiary process. A stage of finality has not yet been arrived at in the adjustment of the matter under the changed conditions, but the position as it appears to-day is explained by Dr. Juritz, and should be studied by farmers who are using, or who are contemplating the use of, the fertilizer. In so far as the sale of basic slag in the Union is concerned, there was a regulation to the effect that it must contain at least 12 per cent. of phosphoric oxide soluble in citric acid. Owing to war conditions, this percentage was reduced, as a temporary measure, to

10 per cent., but in view of the present position, this lower percentage has now been fixed by the Government, so that in future (or until such time as it may be found advisable to make other provisions) the minimum phosphoric oxide content allowed in the sale of basic slag will be 10 per cent.

UNIVERSITY OF LONDON.

SENATORIAL ELECTION, OCTOBER, 1922.

Dr. George Senter, D.Sc. (Lond.), Ph.D. (Leipzig), F.I.C., Principal and Head of the Department of Chemistry, Birkbeck College, has been selected by the University of London Graduates' Association as candidate for the vacancy in the representation of Science Graduates on the Senate of the University of London, caused by the election of Dr. Walmsley as Chairman of Convocation.

GENERAL NOTES.

INTERNATIONAL INSTITUTE OF AGRICULTURE, ROME.

BUREAU OF STATISTICS.

The International Institute of Agriculture communicates that last month's favourable forecasts in regard to the crop in the United States have been, in the main, confirmed by the reports recently to hand from the Washington Department of Agriculture. The earliest estimates of Canadian crops, now received by the International Institute, are equally favourable.

The aggregate yields in these two principay exporting countries may therefore be estimated at 31.5 million metric tons of wheat, 3.0 million tons of rye, 5.4 of barley and 25.5 million of oats.

In comparison with 1921, there is an increase of 5.8 per cent. for wheat, 49.8 per cent. for rye, 17.4 per cent. for barley, and 16.2 per cent. for oats.

On the other hand, the yield of maize in the United States, usually amounting to about three-fourths of the world's crop of this grain, is at present estimated at 7 per cent. below the final out-turn of 1921, but nevertheless is slightly above the preceding five years' average.

The data of European yields of breadstuffs (wheat and rye) are so far published only for Belgium, Bulgaria, Spain, Finland, Greece, Hungary and Poland. The aggregate estimates for the countries mentioned amount to 7.4 million metric tons of wheat and 7.3 million tons of rye, showing a decrease of 10 per cent. as regards wheat but an increase for rye of nearly 10 per cent. as compared with the corresponding productions in 1921.

In North Africa (Morocco, Algeria, Tunis) the crops of wheat and barley this season are decidedly below those of last year, as they have suffered from drought.

The aggregate crops of these countries (0.8 millions metric tons of wheat, and 0.9 millions metric tons of barley) are only 48 per cent. of those in 1921.

Summing up the data of those countries which have furnished official estimates of their wheat yield (about 65 per cent. of the aggregate for the northern hemisphere) we obtain a wheat crop of 49.5 million metric tons, being 7 per cent. more than that grown in 1921, and 9 per cent. over the average of the previous five years. These percentages will probably undergo some reduction, as it is well known that the cereal yield in some of the principal European countries is likely to be less than in 1921.

A fresh telegram from the United States' Government has reached the Institute at the last moment, indicating by reports up to 15 July some improvement in most of the crops in the United States. Some excellent yields have been ascertained from wheat threshings in the South, but the quality is rather low and the crop usually less than expected. Maize has improved materially in the south-east, but is still below average in condition. Potatoes and tobacco are generally good. Cotton is making good progress.

PURCHASE OF ARSENIC.

Dr. McDonald further asked the Minister of Health if, in view of the fact that large quantities of arsenic could be obtained from chemists by individuals merely signing a poison book, he would take steps to discontinue this practice.

Sir A. Mond replied: The sale of arsenic is governed by Sections 1 and 2 of the Arsenic Act, 1851, and by Section 17 of the Pharmacy Act, 1868. It would require

further legislation, which will be considered, to deal with the point raised by the hon. member.

SCIENTIFIC INSTRUMENTS

Mr. Raffan asked the President of the Board of Trade whether he had received the report of the committee appointed by him to deal with the application for a further duty of 33⅓ per cent. upon optical and scientific instruments; whether the terms of reference to this committee included the consideration of employment in the making of dental, surgical, and medical instruments; if so, whether evidence on this point was submitted to the committee; and whether the value of imports of dental, surgical, and medical instruments during the six months ending June, 1922, and similar figures for the same period in 1921.

Mr. Baldwin replied: The answer to the first part of the question is in the negative. The complaint referred to the committee does not relate to dental, surgical and medical instruments other than a very limited number, which are included in the lists of optical elements, and of optical and scientific instruments issued by the Board of Trade under section 1 (5) of the Act. These particular goods are products of industries covering a much wider range, as to employment in which the committee were specifically directed to report, and their report, when presented, will no doubt deal with this aspect of the matter. The declared value of dental, surgical, medical and veterinary instruments (except optical) registered as imported into the United Kingdom during the six months ending June 30, 1922, was £12,427. The corresponding value for the six months ending June 30, 1921, was £20,592.

KANNENSTINE, FABIAN M.—Formation and Life of Metastable Helium. *Astrophysical Journal*, 55, 345-353, May, 1922. The University of Chicago Press, Chicago, Ill.

Abstract.

Current-potential curves for alternating and intermittent arcs in pure helium between a Wehnelt cathode and nickel anode were obtained by use of a Braun-tube oscillograph, for pressures of from 0.06 to 2 mm. With alternating voltages, the striking potential for each half-cycle was 20 volts or more for frequencies of 200 or less, but for frequencies of 220 cycles and above, the current started at about 5 volts and soon reached a saturation value until about 25 volts caused a further increase. In all cases the breaking potential was about 5 volts. To form the intermittent arc, the voltage was periodically dropped from 36 to some lower predetermined value. If this lower potential was less than 4.6 volts, the arc was suddenly extinguished; if between 4.6 and 23.7 volts, the arc died out gradually; and if it was 25.3 volts or above, the arc was maintained. All the foregoing values include a correction of 1.1 volts added to the actual readings to bring them in agreement with accepted results.

Evidence as to the life of metastable helium.—To explain various experimental results, it has been suggested that atoms of helium, partially ionized by electronic collisions of 20.8 volts or more and hence capable of complete ionization by further impacts of 4.8 volts or more, remain in this metastable condition for an appreciable time. The foregoing results not only conrm this suggestion, but also show that under the circumstances of this experiment the metastable form persists for about 0.0024 second.—GORDON S. FULCHER.

CHILD, C. D.—A Continuous Spectrum from Mercury Vapour. *Astrophysical Journal*, 55, 329-344, May, 1922. The University of Chicago Press, Chicago, Ill.

Abstract.

Continuous spectrum of mercury, red to ultra-violet.—(1) *Conditions for emission in discharge tube.* A continuous spectrum identical with the fluorescence spectrum is emitted in addition to the ordinary line spectrum only when (*a*) the temperature of the vapour is above 120° C. and below 300° to 400°, depending on the pressure, when (*b*) the pressure is above 1 mm., when (*c*)

the current-density is low, of the order of 10 amp/cm or less, and (*d*) when very little air or other contaminating gas is present. An influence machine or transformer is better as a source of current than an induction coil, especially one with condensers. Ionization of the vapour is not necessary for the emission of this spectrum since it was obtained with only 7 volts between the Wehnelt cathode and surrounding cylinder. (2) *In explanation* it is suggested that *the carriers of the spectrum* are molecules consisting of two or more atoms, which emit the fluorescence spectrum as a result of excitation by ultra-violet radiation λ 2536 emitted by atoms struck by electrons with energies corresponding to 4.9 volts or more.

Continuous spectrum of sodium.—Preliminary observations on heated sodium vapour in a discharge tube indicated that a continuous spectrum was present but much fainter than the line spectrum.

Ionization potential for mercury.—Some observations on the current from a heated lament to a concentric electrode as a function of voltage seem to show that the ionization potential varies with the temperature, reaching a minimum for about 140°, when it was 3 volts less than for 50°.

Change in chemical behaviour of mercury vapour at about 120° *C.*—Above that temperature it *reacts with air* to form a dark compound, but not below. This reaction is associated with the appearance of the continuous spectrum. — GORDON S. FULCHER.

RAMSAY MEMORIAL FELLOWSHIPS.

The Ramsay Memorial Fellowship Trustees have awarded a Ramsay Fellowship of the value of £300, tenable for one year, but renewable for a second year, to Mr. Robert Winstanley Lunt, Ph.D., of the University of Liverpool, and of University College, London. Mr. Lunt will continue to undertake chemical research at University College, London, on Chemical Effects of Electromagnetic Waves over the Frequency range 10 -10 cycles.

The Trustees have awarded the Glasgow Ramsay Fellowship of £300 to Mr. John [illegible] of Glasgow University, who will continue his research on the Chemistry of the Terpenes.

The Trustees have also granted a special Fellowship of £300 for one year, to Mr. William Davies, M.Sc., who has already *held a Ramsay Fellowship for two sessions*, and whose work, especially that on the preparation of synthetic reagents from the toluic acids, shows special promise.

The Danish Ramsay Fellowship has been awarded to Mr. Kristian Höejendahl, of the University of Copenhagen, who will pursue his research in the University of Liverpool.

Two Swedish Ramsay Fellowships have been awarded to Dr. J. O. G. Luhlin and Mr. A. W. Bernton respectively.

Two Norwegian Ramsay Fellowships have been awarded to Mr. Dag Nickelsen, who will work at the Imperial College of Science and Technology, and Miss Milda Prytz, who will work at University College, London.

The Trustees have placed at the disposal of the National Research Council of the United States of America a special Ramsay Fellowship of the value of £350; and Dr. Charles G. Piggot, of Baltimore, has been elected to that Fellowship, and will begin work at University College, London, in October.

University College,

27 July, 1922. *Gower Street.*

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

PASS LIST.

July Examinations, 1922.

The following Associates have passed th examination for the Fellowship:—

In Branch A II., Metallurgy (1 entere and passed): Oakley, Percy Dale, B.S (Lond.).

In Branch E., The Chemistry, includi Microscopy, of Food and Drugs and Wat

(4 candidates entered of whom 2 passed): Essery, Reginald Ernest, B.Sc. (Bris.); Walmsley, James Rawson, A.M.C.T.

The following candidates have passed the examination for the Associateship:—

In General Chemistry (45 candidates entered, of whom 28 passed): Bateman, Alan Hamilton, Birkbeck College, London; Berchem, Rudolph Otto George Alexander, Birkbeck College, London; Brow, William Thomas, B.Sc. (Edin.), Heriot-Watt College and the University, Edinburgh; Carmichael, Kenneth Francis, Heriot-Watt College, and the University, Edinburgh; Cooler, Harold Frederick, East London College; Crawley, Ailsa Victorian, University College, London; Easterbrook, William Caulton, Royal Technical College, Glasgow; Eastland, Cyril Jack, School of the Pharmaceutical Society; Fairgrieve, Jessie Helen Carroll Dick, Heriot-Watt College, Edinburgh; Fritz, Jack, Leeds Central Technical School; Grant, James, Heriot-Watt College, Edinburgh; Haslam, Margaret Mary, B.Sc. (Lond.); Herd, Clifford Walter, University College and Sir John Cass Technical Institute, London; Kekwick, Leslie Oliver, University College, London; Luke, James Trewhella, King's College, London; Mathie, John Richardson, Royal Technical College, Glasgow; Maunder, Archibald George Daw, University College, London; McGregor, Percy, Heriot-Watt College, Edinburgh; Melhuish, Barradale Whiddon, School of the Pharmaceutical Society; Miller, Herbert Frederick, Birkbeck College, London; Mitchell, Robert Edward, South Western Polytechnic, London; Polglaze, Gordon Henry Francis, King's College, London; Richardson, William Robert, University College, London; Rigden, Horace Walter; Schorn, Edwin John, Heriot-Watt College, Edinburgh; Stokoe, Hector Vivian Thurlbeck, B.Sc. (Lond.), Armstrong College, Newcastle-on-Tyne; Tucker, John Morgan, University College, London; Wallace, Dorothy Orford (Nat. Sci. Tripos, Cantab.), Girton College, Cambridge.

Under Regulations in force prior to March, 1920.

In Branch (a), Mineral Chemistry (4 entered, of whom 2 passed): Cutting, Percival Harman; Laing, Thomas Edward, South Western Polytechnic, London.

In Branch (d), Organic Chemistry (4 entered, of whom 3 passed): Dodds, George Elliot, Heriot-Watt College, Edinburgh; McCartney, William, Heriot-Watt College, Edinburgh; Renton, Archibald, Heriot-Watt College, Edinburgh.

In Branch (e), The Chemistry, including Microscopy, of Food and Drugs and Water (3 entered, of whom 1 passed): Pearson, Margaret, South Western Polytechnic and Battersea Polytechnic, London.

By Order of the Council,

RICHARD B. PILCHER,

Registrar and Secretary.

30, Russell Square, London, W.C.1.
July 28th, 1922.

CHROMIUM HYDROXIDE (*AIR DRIED*).

By A. J. W. Foster.

It was thought that Chromium Hydroxide probably contained water of constitution. The following experiment was therefore performed:—

Pure Chromium Hydroxide was obtained by precipitation with an alkaline hydroxide from a Chromium Salt. The precipitate was filtered at the pump and was well washed. The wet mass was placed on clean filter papers and was exposed to the air till thoroughly dry. A weighed quantity of the dry substance was then ignited in a crucible and the loss in weight determined.

This was repeated three times. The percentage of water in the original substance was then easily calculated, and then the formula obtained in the usual way.

0.99 gm Chromium Hydroxide lost 0.49 gm water. %water 49.49
1.415 gm Chromium Hydroxide lost 0.695 ,, ,, %water 49.11
1.67 gm Chromium Hydroxide lost 0.825 ,, ,, %water 49.40
Average % water 49.33.

This agrees with formula $Cr_2O_3 + 8\ H_2O$ or $2\ Cr(OH)_3 + 5\ H_2O$.

Woodleigh, Mytholmroyd, Yorks.

New Patents.

This list is specially compiled for *Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, *from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.*

Latest Patent Applications.

19422—Ashcroft, E. A.—Treatment of sulphide ores, &c. July 14.

19405—Backstrom, H. M.—Apparatus for catalytic oxidation of ammonia with oxygen. July 14.

18897—Dietzsch.—Treatment of copper ores. July 10.

Specifications Published This Week.

163975—Aluminium Co. of America.—Method of *manufacturing aluminium chloride.*

158569—Soc. E. Barbet et fils et Cie.—*Evaporating* apparatus.

182411—Courtaulds, Ltd., and Jones, R. O.—Effecting the separation of sodium carbonate from liquors or solutions containing caustic soda.

Abstract Published This Week.

Sulphuric acid.—Patent No. 180546.—Some improvements in the apparatus and process of manufacturing sulphuric acid has been invented by Mr. E. A. Gaillard, of 33, Ronda Universidad, Barcelona, Spain. A stream of cold acid is made to trickle permanently over the whole inner surface of the walls of the lead chambers or towers for the purpose of protecting them from corrosion. Preferably chambers are constructed as cylinders, or reversed truncated cones, cold acid being directed on to the walls by a turbine of resistant material placed axially near the top of the chamber and fitted with jets or wings to ensure the wetting of the whole inner surface. Nitrous vitriol may be introduced into the chamber in the same way.

Messrs. Rayner & Co. will obtain printed copies of the published specifications, and forward on post free for the official price of 1s. each.

UNIVERSITY OF BIRMINGHAM.

FACULTIES.

Science: Subjects—Mathematics, Physics, Chemistry, Zoology, Botany, Geology, Engineering (Mechanical, Civil, Electrical), Metallurgy, Mining (Coal, Metal, Petroleum), Bio-Chemistry of Fermentation.

Arts: Subjects—Latin, Greek, English, French, German, Italian, Spanish, Russian, Philosophy, History, Music.

Medicine: All subjects leading to Degrees and Diplomas in Medicine and Dentistry.

Commerce: Subjects leading to Degrees in Commerce.

Department of Training for Teachers:
Department of Social Study:

Department of Malting and Brewing.

THE SESSION 1922-23 COMMENCES ON OCTOBER 2nd, 1922.

ALL COURSES AND DEGREES ARE OPEN TO BOTH MEN AND WOMEN STUDENTS.

In the Medical School, Courses of Instruction are arranged to meet the requirements of other Universities and Licensing Bodies.

Graduates, or persons who have passed Degree Examinations of other Universities may, after one year's study of research take a Master's Degree.

Separate Syllabuses with full information as to Lecture and Laboratory Courses Fees, Regulations for Degrees, Diplomas etc., Exhibitions and Scholarships, are published as follows:—

1. Faculty of Science.
2. Faculty of Arts.
3. Faculty of Medicine.
4. Faculty of Commerce.
5. Department of Social Study.
6. Department of Biology and Chemistry of Fermentation.
7. Exhibitions, Scholarships, etc.,

and will be sent on application to the **Registrar.**

THE CHEMICAL NEWS,

VOL. CXXV., No. 3253

A NEW PHYSICO-CHEMICAL LAW.

By Hawksworth Collins.

The Heat of Formation of an Element is Proportional to the Product of the Atomic Weight and the Change of Volume.

The following 8 tables give:

(1) the atomic weights of several elements;

(2) the observed Specific Gravities of the same;

(3) the observed Specific Gravities of several common molecules; and

(4) the observed Heats of Formation of the same.

From these four sets of data,

(1) the Relative Volumes of the elements, when in combination, are deduced; and also

(2) the Heat of Formation of each element, when combining to form molecules.

The theoretical results never differ by more than 1 per cent. from the observed.

The relative volumes and the theoretical heats of formation have been found not only from the data here employed, but from hundreds of others.

These results are proved to be true from the fact that the heat of formation of each element of atomic weight greater than 22 is proportional to the product of its atomic weight and its change of volume.

There are some apparent exceptions to this at present, probably owing to mistakes in the observed heats of formation. For the general method of obtaining these is by finding one of them and then calculating others from it. For instance, in the case of Strontium, the compound $SrCl_2$ was first determined by Thomsen, and then all the other compounds of Sr *calculated* from it. The consequence is that, if $SrCl_2$ is wrong, then they are all wrong. Again, even if $SrCl_2$ is correctly determined, it does not follow that the others are right, because the relative volume of Sr in $SrCl_2$ may not be the same as that in another compound.

Again, Thomsen takes it for granted that the acid radicals (SO_4, *e.g.*) are always the same in all compounds, which does not happen to be the case. The total relative volume of SO_4 varies in certain definite manners.

The heat of formation of each element of atomic weight less than 22 is also proportional to the product of its atomic weight and its change of volume; but there is a great difference between the two series of elements, as shown by the numbers 795 and 120.

The truth of the law is also evident from other considerations as follow:—

(1) Whenever Oxygen occupies the volume 7.53, its heat of formation is 32341.

(2) Whenever O occupies the vol. 4.45, its H.F. is 71515.

(3) Whenever O has the vol. 2.51, its H.F. is 96155.

(4) *These 6 numbers for the R.V. and H.F.* of Oxygen all give the same original relative volume for Oxygen, which proves that a deep-seated discovery has been made with regard to them.

(5) Whenever other elements have two or more relative volumes in combination, their heats of formation are always proportional to the change of volume, and therefore give the same original volume, which in its turn gives the correct S.G. of the element.

The tables are intended to be employed in the following manner, the molecules numbered 1—4 being taken as examples:—The S.G. of PbO is given by Geuther as 8.74-9.09. If 206+16 be divided by 8.9, the result is 24.95, which splits up into 17.42 and 7.53; the former being a common volume for Pb, and the latter a common one for Oxygen.

The H.F. is given as 50800 by an American publication. If 50841 be taken as the value, *this number can be split up into* 32341 (which is always the H.F. corresponding with Oxygen when its volume is 7.53) and 18500. The latter portion splits up into $120 \times 0.75 \times 206$, where 206 is the atomic weight of Pb, and 120 is a constant. If 0.75 be added to 17.42, the result is 18.17, and if 206 be divided by 18.17 the result is 11.34, which is exactly the S.G. of Pb.

If similar operations be performed in the cases of the other three compounds of Pb., it will be seen that the original relative volume of the element in each case is 18.17, which gives the correct S.G. of the element Pb in the *solid* state.

An exactly similar state of affairs is shown to exist in several other common molecules, whenever the experimental data required are complete.

It is evident from the large number of mathematical operations which have to be performed upon the experimental data with regard to each element and molecule, that there is no possibility of error in the deduction that the H.F. of an element varies as the product of the atomic weight and the change of volume.

The "change of volume" here means the difference between the volume of the element in the solid state at 15° C. and the volume of the element when in combination with others at 15° C. Consequently the experimental data with regard to such elements as Cl, Br and O are, and apparently must remain, incomplete as far as this discovery is concerned.

TABLE I.

Relative Volumes.	Theoretical. S.G.	Observed S.G. and Observer.
1. PbO (red) 17.42+7.53	8.9	8.74-9.09 Geuther
2. $PbCl_2$ 19.39+2(15.085)	5.59	5.29 Monro 5.68 Karsten
3. PbI_2 19.39+2(27.73)	6.14	6.12 Rodwell
4. $PbCO_3$ 19.81+20.55	6.59	6.60 Smith
5. Sb_2O_3 2(21.29+2.51)+4.45	5.5	5.251 P & J 5.566 Mons
6. Sb_2O_5 2(21.29+2.51+7.53)+4.45	4.74	6.525 Boullay 3.78 P & J
7. Sb_2S_3 2(21.29+10.51)+15.53	4.22	4.223 23° Cooke
8. ZnO_2H_2 11.53+7.53+2.51+2(5.76)	2.99	2.68 Nickles 3.06 Filhol
9. ZnF_2 11.53+2(5.33)	4.64	4.612 12° Clarke
10. ZnI_2 12.6+2(27.73)	4.69	4.696 Bodeker
11. Cu_2S 2(9.05)+10.51	5.522	5.521-5.795 Scheerer
12. Cu_2I_2 2(9.74)+2(27.73)	5.07	4.41 Schiff 5.7 Rodwell
13. As_2O_3 2(19.58+2.51)+7.53	3.83	3.85 Claudet
14. MoO_2 15.53+2(2.51)	6.23	6.44 16° Monro 5.67 Bucholz
15. $HgCl_2$ 17.05+2(15.085)	5.72	6.223 P & J 5.42 Boullay
16. HgI_2 16.62+2(27.73)	6.29	6.27 Tschermak 6.32 Boullay
17. Bi_2O_3 2(24.29)+3(2.51)	8.3	8.5 Dumas 8.21 Herapath
18. $NaHCO_3$ 11.85+5.76+20.55	2.20	2.205 Schroder 2.192 P & J
19. Na_2CO_3 2(11.85)+20.55	2.40	2.407 Favre
20. Fe_3O_4 3(11.65)+3(2.51)+4.45	4.94	4.960 Gerolt
21. Fe_3O_4 (cryst) 3(10.08)+2(2.51+4.45)	5.25	5.25 Gorgeu
22. Fe_2O_3 2(11.65+2.51)+4.45	4.9	4.679-5.135 P & J
23. SnO 18.08 + 2.51	6.51	6.6-6.45 0° Ditte
24. SnO_2 18.08+2.51+4.45	6.0	6.019 (artif cryst) Leeds
25. CdSe 14.57+11.25	7.32	8.8 Little 5.80 Margottet
26. CdO 15.16+2.51	7.19	8.11 Werther 6.95 Karsten
Cr_2O_3 2(8.78)+3(2.51)	6.06	6.2 Schiff 5.21 Wohler(cryst)
28. Cr_2O_3 2(8.78+2.51)+4.45	5.62	6.2 Schiff 5.21 Wohler
CaS 12.24+15.53	2.59	2.58 Maskelyne
30. $CaBr_2$ 12.24+2(23.09)	3.39	3.32 11° Bodeker
$CaCO_3$ 13.25+20.55	2.96	2.958-2.995 Breithaupt
32. CaO 13.25+4.45.	3.164	3.161 Karsten 3.18 Filhol
CaO 14.33+2.51.	3.325	3.32 Levallois
34. NiO 8.13+4.45	5.96	5.597 P & J 6.398 Bergemann
CoF_2 11.45+2(5.33)	4.39	4.43 V N
36. Ag_2O 2(13.61)+2.51	7.74	7.521 Schroder 8.26 Karsten
Ag_2S 10.25+13.61+10.51	7.16	7.164 Dauber
38. CeO_2 19.20+2(2.51)	7.16	7.09 14° Nordenskiold 7.65 VN
$SiBr_4$ 18.91+23.09+3(27)	2.83	2.813 0° Pierre
40. WO_2 12.89+2(2.51)	12.06	12.11 Karsten
Ta_2O_5 2(21.98)+5(5.21)	7.86	7.986 Rose 7.653 Rose
42. ThO_2 13.62+7.53+4.45	10.32	10.22 17° Nilson

P & J = Playfair & Joule.
C K = Chemiker Kalender.
V N = Van Nostrand.

TABLE II.

	Theoretical Heat of Formation.		Observed H F
1.	PbO (red) +18500+32341	=	50841 50800 50300 T
2.	$PbCl_2$ -30200+2(56132)	=	82064 82770 T 83900
3.	PbI_2 -30200+2(36227)	=	42254 41850 39800 T
4.	$PbCO_3$ -40607+210765	=	170158 170000 166700
5.	*Sb_2O_3 -2(48200)+(2(96155)+71515*	=	*167425 166900*
6.	Sb_2O_5 -2(48200)+2(96155+32341)+ 71515	=	232107 231200
7.	Sb_2S_3 -2(48200)+2(49959)+30681	=	34199 34400
8.	ZnO_2H_2 -14900+32341+96156-2(15300)	=	82996 82680 T 83500
9.	ZnF_2 -14900+2(76820)	=	138740 138220
10.	ZnI_2 -23233+2(36227)	=	49231 49230 T
11.	Cu_2S -2(14907)+49959	=	20145 20300 18260 T
12.	Cu_2I_2 -2(20083)+2(36227)	=	32288 32520 T
13.	As_2O_3 -2(35000)+2(96155)+32341	=	154651 154670 156400
14.	MoO_2 -50900+2(96155)	=	141410 142800
15.	$HgCl_2$ -57400+2(56132)	=	54864 54490 T 53300
16.	HgI_2 -47000+2(36227)	=	25454 25200 25640 T
17.	*Bi_2O_3 -2(75200)+3(96155)*	=	138065 139200
17.	$NaHCO_3$ +32706-15300+210765	=	228117 227000
19.	Na_2CO_3 +2(32706)+210765	=	276177 273700 272640
20.	*Fe_3O_4 -3(31570)+3(96155)+71515*	=	*265270 265200*
21.	Fe_3O_4 -3(21000)+2(96155+71515)	=	272340 270800
22.	Fe_2O_3 -2(31570)+2(96155)+71515	=	200685 199150
	SnO -28040+96155	=	68115 68090
24.	SnO_2 -28040+96155+71515	=	139630 137200 141300
	CdSe -23200+47045	=	23845 23700
26.	CdO -31000+96155	=	*65155 66300* 63900 crys
	Cr_2O_3 -2(10364)+3(96155)	=	267737 267800 cryst
28.	Cr_2O_3 -2(10364)+2(96155)+71515	=	243097 243800 amorph
	CaS +64420+30681	=	95101 94300
30.	$CaBr_2$ +64420+2(45244)	=	154908 154920 T
	$CaCO_3$ +59568+210765	=	270333 270800 269100
32.	CaO +59568+71515	=	131083 131500
	CaO +54376+96155	=	150531 151900
34.	*NiO -10000+71515*	=	*61515 61500 57900*
	CoF_2 -32920+2(76820)	=	120720 120340
36.	Ag_2O -2(45080)+96155	=	5995 5900 T 7000
	Ag_2S -45080-1900+49959	=	2979 3000 3330 T
38.	CeO_2 +32290+2(96155)	=	224600 224600
	$SiBr_4$ -24600+45244+3(17000)	=	71644 71000
40.	WO_2 -60060+2(96155)	=	132250 131400
	Ta_2O_5 -2(88500)+5(96155)	=	303775 301500
42.	ThO_2 +219000+32341+71515	=	322856 326000

T = Thomsen. The other values are taken from an American publication, the names *of the observers not being given.*

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(To be Continued.)

ALUMINA.

Hydrolysis of Aluminum Salts.

By Wilder D. Bancroft.

(*From the Journal of Physical Chemistry, June, 1922.*)

(*Continued from Page 72.*)

"*An experiment was made accordingly with a view to determining whether the tartaric acid used along with aluminum salts played the rôle of a carrier,* so that it might be possible to use any free acid along with only a small quantity of tartaric acid. The result obtained, however, proved that the tartaric acid plays no such intermediary part in mordanting wool with aluminum salts; on the contrary, a considerable amount of tartaric acid must be present (at least half the theoretical amount necessary to form aluminum tartrate) in order to fix on the wool sufficient alumina to yield full, bright colours."

Knecht[1] evidently believes in starting with aluminum sulphate. "The aluminum mordant *par excellence* for wool is aluminum sulphate, either alone or in conjunction with acids or acid salts. In some cases the sulphate is used without any additions. Most generally, however, a mixture of the sulphate with tartar or tartar substitutes is required to obtain full and brilliant colours which do not rub off. These tartar substitutes are mostly sodium bisulphate or oxalates, or they consist of tartar which has been prepared with sufficient sulphuric acid to convert all the potassium into potassium sulphate. From the foregoing it appears that none of these "substitutes" can replace the tartar completely because the action of the latter depends on the formation of aluminum tartrate by *double decomposition*. They have, of course, some effect, as has also sulphuric acid. *For a full shade about 6 to 8 per cent. aluminum sulphate and 5 to 7 per cent. tartar (of the weight of the wool) are necessary.* The quantity of tartar may be reduced to about half this amount, or it may be partly or even wholly replaced by sulphuric, hydrochloric, oxalic acid, bisulphate of sodium, etc., with very good, although not equally fine, results. About 4 per cent. of sulphuric acid (of the weight of the wool) is used, if the amount of water does not exceed 50 to 60 times the weight of the wool; otherwise more acid must be applied. When sulphuric acid has been used in mordanting it is often beneficial to add about 5 per cent. sodium acetate to the ultimate dye-bath to neutralise the mineral acid which always remains in the wool fibre (and which otherwise would be converted into potassium sulphate if tartar had been employed). The mordanting bath is prepared with the necessary quantities of aluminum sulphate and tartar (or its substitutes), and the wool is entered at a low temperature. *During one and a half hours the bath is heated gradually to boiling,* and boiled for half an hour more. When the bath has cooled down, the wool is taken out and thoroughly washed in water; boiling out with water is beneficial. It has been shown that washing is absolutely necessary to remove all loosely adhering mordants and to prevent rubbing of the ultimate colour. The washing, moreover, removes some of the acid, which is absorbed by the wool, and would be injurious in dyeing."

I am inclined to believe that accurate experiments will show that the presence of sulphate in the mordanting bath is probably always detrimental.

Aluminum oxalate behaves very much like aluminum tartrate, but is not quite so good. According to Knecht[1] aluminum acetate decomposes too readily to be used for wool; but this can hardly be the whole truth. The use of lactic acid instead of tartaric acid has also been suggested.

Matthews[2] has rather a hard time with the theory of mordants, chiefly because he copies with but slight changes from Ganswindt's book published in 1903. "The *mordanting of the animal fibres with metallic salts is probably for the most part a* chemical process, the metallic salts or oxide forming a chemical compound with the substance of the fibre. It is usually considered in the case of mordanting wool, for instance, with metallic salts, that the metal is precipitated in the fibre as the oxide or hydroxide; in certain methods of printing, this may be the fact, but in the ordinary processes of mordanting wool for dyeing, it cannot be considered that the oxide of the metal is directly precipitated

1 *Knecht, Rawson and Loewenthal*: "*A Manual of Dyeing,*" 238 (1910).

1 *Knecht, Rawson and Loewenthal*: "*A Manual of Dyeing,*" 237 (1910).

2 "*Application of Dyestuffs,*" 602 (1920)

in the fibre. It is possible, for instance, to mordant the wool by boiling in a bath containing a solution of alum, squeezing, and then passing through a bath containing ammonia water; this would cause the precipitation of aluminum hydrate on and in the fibre as an insoluble body. As an actual fact, however, the mordanting is not done in this manner, but is carried out by boiling the wool with a solution of alum and tartar, which it cannot be presumed would lead to the precipitation of aluminum hydrate."

Even with Ganswindt to fall back on in silence, this paragraph is quite extraordinary; but the clue is to be found elsewhere. Matthews[1] has evidently not understood any of the work of Liechti and Suida or of Knecht, because he enters into an elaborate explanation that sodium chloride is dissociated electrolytically in water and thereby made more active, giving this as a help in understanding the theory of Knecht, although Knecht[2] himself speaks of hydrolytic dissociation, and the case that Matthews is discussing is the decomposition of rosaniline hydrochloride into the free base and hydrochloric acid, which is not a case of electrolytic dissociation.

Adsorption of Alumina by Silk.

Silk behaves towards alumina mordants very much as wool does, though less intensely. Knecht[3] states that "in silk dyeing alum has not been replaced yet by aluminum sulphate[4] probably owing to the circumstance that slightly basic alum decomposes more readily than basic sulphate on account of the ammonium or potassium sulphate present. . . . Aluminum sulphate-acetate and nitrate-acetate are used in a similar way. . . During the steeping process the silk absorbs basic sulphates or basic sulphate-acetates or nitrate-acetates. By the subsequent treatment with water or silicate of soda or soap, the basic salts are decomposed and aluminum hydroxide is precipitated in the fibre.' Heermann[5] claims to have proved that, with silk, the basic mordants of aluminum, chromium, iron and tin are present as hydrous oxides and not as basic salts. Heermann[1] has discussed the various theories of mordanting, and mentions favourably what he calls the catalytic theory according to which the fibres bring about the hydrolytic decomposition of the mordanting salts catalytically. It is easy enough to see what he has in mind, for the hydrolysis of the aluminum salts is increased by wool or silk; but this cannot properly be called catalytic, because the fibre is not in the same condition after the process as before. It is mordanted.

Heermann also advances a theory of his own which he calls the ionatic theory of mordanting. He considers mordanting "as the electrolytic precipitation of certain ion complexes in consequence of the preponderating electro-affinity[2] of the fibres (as opposed to that of the cations of the mordant) and in consequence of the [electrolytic?] dissociation of the mordant which is perhaps increased by the catalytic power of the fibres or of the cations of the mordant."

This can mean anything or nothing, so Heermann explains his views in more detail. "There are fibres of greater and lesser electro-affinity and mordants of greater and lesser electrolytic dissociation. The affinity of a mordant to a fibre reaches its maximum when the greatest difference between the electro-affinities of the fibre and of the ions of the mordant. The fibre, having the greater electro-affinity, discharges successively the ions or ion-complexes of the mordant, since these have a lesser electro-affinity. The ion-complexes plexes of the mordant, since these have a posit themselves, while in the nascent, state, uniformly on the fibre and are at first held there in a labile state along with the acid. Washing removes most of the acid of the mordanting salt, and the resulting base is fixed fast to washing." It is perhaps not surprising that no further use has been made of this theory even by the enthusiastic author.

Adsorption of Alumina by Cotton.

Over a century ago it was pointed out that "the attraction between aluminous

1 *Knecht, Rawson and Loewenthal*: "*A Manual of Dyeing*," 15 (1910).
2 "*Application of Dyestuffs*," 588 (1920).
3 *Knecht, Rawson and Loewenthal*: "*A Manual of Dyeing*," 238 (1910).
4 *Both are used according to Gänswindt*: "*Theorie and Praxis der modernen Färberei*," *II.*, 18 (1903).
5 *Chem. Centralblatt*, 1905, I., 128.

1 *Ibid.*, 1904, II., 674.
2 [*He is referring to Bodländer and Abegg' theory of electro-affinity.*]
3 *Bancroft*: "*Philosophy of Permanent Colours*," 2, 148 (1813).

basis and the fibres of linen and cotton is much weaker than that which subsists between the same basis and the fibres of wool and silk." The knowledge that alum cannot be used by itself to mordant cotton turns back to a very early period. Bancroft[8] states that "when a solution of alum is applied to calico which has received no impregnation, it will not easily be decomposed; but, on the contrary, a great part of it will again crystallise, so soon as the water which held it in solution has evaporated: and none but feeble colours can be raised upon such a basis. But when calico has been impregnated by *such astringent and animal matters as are obtained from myrobalans and buffaloes' milk, the alum will not only be decomposed, but the alumine will combine with the astringent and oily matters so obtained, and a basis will be laid for a colour almost as durable as the Turkey red.*"

"For the common madder red, linen or cotton, after being boiled in a weak lixivium of potash or soda, and well rinced and dried, is to be macerated in a decoction of powdered galls, employed after the rate of four ounces to every pound of linen or cotton to be dyed; and being equally impregnated with the soluble matter of the galls and afterwards dried, the linen or cotton is to be alumed, by soaking it thoroughly in a saturated luke-warm solution of alum, employed also at the rate of four ounces to each pound of linen or cotton; after having previously neutralised the excess of its acidity, by adding to the solution one ounce of soda for every pound of alum: this being done, and the linen or cotton moderately and equally wrung or pressed, it is to be well dried, and afterwards alumed a second time, dissolving for that purpose half as much alum as for the first aluming, and adding to it the residue of the former solution. After this second aluming, the linen or cotton is to be again well dried, and then rinsed, to remove any superfluous part of the alum which may not have been united thereto. *By substituting the acetate of alumine (formerly described) for the solution of alum, just mentioned, a more beneficial effect might be obtained; but it would be attended with a considerable increase of expense.*

"*The use of galls, in this operation, will be readily conceived, by recurring to what I have mentioned, at p. 356 and 357 of my first volume, concerning the effect of myrobalans, when employed by the Hindoos, in causing a more copious precipitation, and a more intimate union of the earth of alum, in or with the calico which had previously imbibed their astringent matter. That this is the only use of galls so employed, I presume, because I have found, by repeated trials, that when employed with madder in the dyeing operation, they add nothing to the durability of the colour.*

"*For every other purpose, except that of decomposing the alum, and increasing the precipitation of alumine,* and, perhaps, its closer union with the fibres of cotton, galls appear to do harm rather than good with madder, by diminishing the vivacity of its colour, and giving it a brownish tinge, without the smallest increase of its durability; on the contrary, I have observed, that when calico printed with acetate of alumine was divided, and one half dyed with madder only, and the other with madder and galls, the colour of the latter, besides a considerable degradation, was injured by being boiled with soap and also by being exposed to the weather sooner, and in a degree considerably greater than the half which had been dyed with madder only."

Napier[1] points out that "alum forms but a weak mordant for cotton goods, owing, probably, to the strong attraction which the sulphuric acid has for the alumina; there are three proportions of acid to every two of alumina. But if we neutralise a portion of the acid, so that no more remains than is necessary to hold the alumina in solution, which, according to experiment is not above a third of the acid contained in the common alum, its properties as a mordant are greatly improved. This may be done by taking a quantity of carbonate of soda in solution, and adding this gradually to the alum solution, stirring all the time: the alumina is at first precipitated, but by keeping up the agitation the precipitate again dissolves: continue until all the precipitate is redissolved. In this state alum is a more powerful mordant for cotton, as the base is held more feebly by the sulphuric acid, and is readily detached by the superior affinity of the cloth to form a mordant; and thus prepared, *it is perfectly pure—any iron formerly present is precipitated in the process. Alum in this state is known by the name of cubical or basic alum, from the form in which it crystallises. We have already referred to Roman alum being superior to other alums.*"

[8] "Philosophy of Permanent Colours," 1.

[1] "*A Manual of Dyeing,*" 120 (1975).

(To be Continued.)

PREPARATION OF SILENT SPIRIT.

(Journal of Indian Industries and Labour.)

Ordinary rectified spirit possesses, besides the smell of alcohol, an odour characteristic of the raw material used in its manufacture. For example, a spirit made from *mahua* flowers will have a characteristic smell in addition to the odour peculiar to pure alcohol; a spirit made from sugar molasses will disclose its peculiar smell besides that of pure alcohol, and so on. This extraneous odour, which persists in the spirit in the absence of a special treatment for its removal, is considered, for apparent reasons, objectionable in spirits intended to be employed in perfumery preparations.

At the instance of the Industries Department, experiments have been carried out at the Muir Central College, Allahabad, on the preparation of silent spirit from ordinary rectified spirit obtained from *mahua* or molasses. The experiments were carried out under the supervision of Professors A. C. Sircar and S. C. Deb, and the products were examined by the Industrial Chemist to the Government of the United Provinces and found to satisfy the requirements of a silent spirit and to compare favourably with any of the foreign samples of silent spirit available in India. The prescriptions worked out are as follows: *Experimental*—

(1) A solution of 12 grammes of potassium permanganate in 100 cc. of water was prepared, 4 cc. of this solution was added to a litre of the alcohol sent and the mixture was kept for two days. A black precipitate was formed from which the alcohol was carefully decanted. It was then kept over quicklime overnight, and finally distilled. Recovery of alcohol was about 85 to 90 per cent. by volume. The specific gravity of the sample thus prepared was 0.788 at 33° C. It compared favourably with the silent spirit (specific gravity 0.794).

(2) 10 grammes of caustic potash were added to a litre of alcohol and the mixture was kept overnight. Next day the mixture was boiled under a reflux condenser for about an hour. The contents of the flask were then distilled and kept over quicklime overnight and finally re-distilled. Recovery of alcohol was about 88 per cent. by volume.

(3) Flax stems were burnt and about 4 oz. of porous charcoal obtained. Any good specimen of purified porous charcoal will serve the purpose as well. The charcoal thus obtained was washed with water to get rid of colouring matter. It was dried and kept in a desiccator till required, when it was put inside a stoppered cylindrical funnel, and about 250 cc. of alcohol to be deodorised was made to percolate through it eight times. The alcohol became nearly odourless. It was, however, slightly coloured owing to traces of colouring matter still left in the charcoal. It was then filtered through 4 oz. of purified animal charcoal. The specific gravity of the product was 0.82.

E. R. WATSON.

CATALYTIC OXIDATION OF SATURATED HYDROCARBONS AND FATTY ACIDS.

A. H. SALWAY AND P. N. WILLIAMS.

This paper contains the results of the oxidation of stearic acid in the presence of manganese stearate as catalyst. A current of oxygen was passed through the acid in the presence of 2 per cent. manganese stearate at 120°-130° C., and the resultant products carefully collected. They consisted of 5 per cent. volatile acids (1 per cent. CO_2, 2.5 per cent. H.COOH, and 1.5 per cent. other acids, including acetic and higher fatty acids). Three per cent. of water soluble acids were obtained, consisting of formic, butyric and acetic acids (average molecular weight 74). The main oxidised product was washed and found to have acid value 206 and sap. value 244 indicating the presence of lactonic substances. These were extracted, and the lactones are considered to have the general formula

$$CO_2H\cdot[CH_2]_n\cdot\underbrace{CH\cdot CH_2\cdot CH_2\cdot CO}_{O}$$

Hexadecane was also oxidised at 120° C. in the presence of 2 per cent. manganese stearate, by passing through it a current of oxygen for 24 hours, 4 per cent. of volatile acids were formed (CO_2, H.COOH, CH_3 COOH and butyric acids). The main oxidised material consisted of 70 per cent. acid substances and 30 per cent. unchanged hexadecane, the former containing hydroxy acids in the form of a pale yellow oil, and value 241, iodine value 0.7, S.G. 0.9611. Hexoic and nonoic acid are possibly present, also lactonic acids.—(*J.C.S. Trans.*, **1922. p. 1343**).

NOTES ON OSMIRIDIUM.

By J. R. Thurlow.

[*The following interesting note on the occurrence of Osmiridium in South Africa is given in the May issue of the Journal of the Metallurgical and Mining Society of South Africa.*]

In view of the interest which is being taken in osmiridium, to judge by the frequent references appearing in the local press, no apology is needed for placing before the members of this Society a brief record of what has been done locally hitherto, and more particularly the results which have been obtained during more recent research on this valuable constituent of banket ore.

The first serious attempt at commercial realisation known to the writer was made by the late Mr. M. Torrente during the period 1912-13, when he succeeded in isolating and fusing into metallic form a small quantity of the metal iridium. Mr. Torrente carried out a considerable amount of research work on concentrated black sand, resulting from milling operations from one of the mines in the Central Rand, and, with a view to establishing commercial relationships, was in correspondence with well-known firms in England and on the Continent for some considerable time.

The next and more successful attempt of this kind occurred during the latter part of 1920 on a mine situate in the Eastern Rand section. It may be noted, however, that periodically during the intervening period more or less frequent references were made to the fact of the presence of rare metals other than gold in concentrated products resulting from metallurgical operations. In the main, however, these references were concerned mostly with analytical work; quite frequently it was a subject for argument in connection with the assaying of concentrates dealt with by the Co-operative Smelting Works.

The nearest approach to its successful isolation from the comercial aspect, viewed in light of present-day knowledge, would appear to be when a small quantity, containing 80 per cent. osmiridium and 3 per cent. platinum, was passed round for inspection at a meeting of this Society, held in October, 1915,* when Messrs. W. H. Jane and F. Davey presented a paper on clean-up room practice.

The history of the 1920 incident is worth recording as an instance of the benefit resulting from scientific training and its natural outcome in the shape of an intelligent interest in whatever work is being undertaken. The curiosity of an assayer led to a discussion as to the nature of a certain blue-black material which he had observed to form a ring round the outer edge of the material passing through a batea. As a sequel a small portion was collected which, on analysis, proved to contain a high percentage of osmiridium. Subsequent investigation indicated that a natural concentration of this product was occurring in the clean-up room, and advantage was taken of its incidence to evolve an economical process of recovery.

After a good deal of experimental work in the direction of hydraulic concentration the simple system described herein was adopted, and meanwhile gradual improvements are taking place which lead to increased efficiency.

In connection with the experimental work it may be mentioned that a magnetic process was tested, and while it was found that osmiridium was attracted with the magnetic metallic iron to the various poles, probably due to the magnetic film covering, no real concentration was effected.

A description of the method referred to above as employed on reduction plants of the Rand Mines Central Mining Group is as follows:—

Proceed in the usual manner to grind in the clean-up barrel all black sands collected from the amalgamation plates and the products from the traps, mortar box heads, Wilfley tables, etc. Pass the ground material through the batea also as usual, but take precaution to keep the final heavy concentrates remaining on the batea separate from the lighter portion which flows over the trap plate. By this means a product containing 40 per cent. of osmiridium concentrate has been obtained, and where this is possible the simplest method of further treatment is to pan off the base metals in a prospector's dish. The most satisfactory method at present of dealing with the product from the collecting sump of the batea is to pass it over a small table, which is covered with open-grained calico resting on fine mesh (100) screen.

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*See "Journal," October, 1915, page 67, *et sequentes*.

The dimensions of this table may be made to suit the working space available; the tables at present in use are about 5 feet long by 2 feet wide, and are made with a small head box and distributing lip similar to those situated at the heads of the tube mill plates. The inclination of the table depends upon the material being concentrated, and the operator can soon decide what this should be to obtain the best result. A grade of 20 per cent. is found to work very well, but as the table is usually a portable one and only set up as required, it can readily be adjusted to suit working conditions. The concentrate caught on the table is further dressed by panning, and the product of this operation is treated by acid. It may be pointed out that as all operations prior to concentration on the calico-covered table are contributory to the ordinary routine, the operating charges per ton of ore treated are practically unaffected.

The following table gives typical analyses of the results obtained by the above means after the product had been subjected to treatment with weak acids:—

	1	2	3	4
	p.c.	p.c.	p.c.	p.c.
Iridium	43.9	44.51	37.86	33.25
Osmium ...	41.9	10.50	10.04	10.47
Ruthenium .		25.38	34.75	37.79
Platinum ..	3.0	7.04	6.37	5.80
Rhodium ...	1.3	0.53	0.82	0.70
Gold	3.0	3.00	3.60	2.86
	93.1	91.05	93.44	90.87

Analyses by R. A. Cooper, Rand Mines, Ltd., Laboratory.

The following copy of a complete analysis of "Black Sand" was given to the writer by the late Mr. M. Torrente:—

	%
Iron	35.32
Sulphur	41.27
Copper	0.05
Lead	0.03
Nickel	0.20
Cobalt	0.24
Zinc	0.48
Arsenic	0.33
Silica	19.65
Alumina	0.50
Chromium Oxide	0.08
Lime	0.17
Magnesia	0.12
Titanium Oxide	0.95
Oxygen, Combined and Hydroscopic Water, Gold and Metals of Platinum Group	0.61

Fine Gold ...	1.33 ozs. per ton of 2,240 lbs.
Fine Silver	2.00 ozs. per ton of 2,240 lbs.
Platinum ...	0.43 ozs. per ton of 2,240 lbs.
Iridium	3.00 ozs. per ton of 2,240 lbs.
Palladium ..	0.45 ozs. per ton of 2,240 lbs.

On sample as received.

As regards the amount of osmiridium present in the ore milled, tests have shown that it varies from 1 ounce per 5,000 tons to 1 ounce per 15,000 tons.

Taking the mean of these extremes, to arrive at a monthly output of 100 ounces osmiridium 1,000,000 tons would have to be milled. The computation is made on tests carried out on mines situated on the Far East Rand. So far only negligible quantities have been isolated on mines west of the Modder Group.

COMMERCIAL VALUE.—The most valuable constituent of the concentrate is iridium, which, however, is subject to violent fluctuations in price according to demand. Thus it realised £120 per ounce two years ago, as compared with one-fifth of this amount per ounce more recently.

COMMERCIAL USES.—The chief uses of osmiridium or the metals contained therein have hitherto been:—

(1) Fountain pen points.
(2) Contacts used in magneto points of the highest class of motor cars.
(3) Irido-platinum alloy used in thermocouples.
(4) Hardening parts of certain dental instruments.
(5) Watch and compass bearings.

RECENT ATTEMPTS TO SEPARATE ISOTOPES.

Abridged from the Journal de Chimie Physique, XIX., 4, 336.

(*Continued from Page* 39.)

While the separation of isotopes by centrifugation was not attempted until 1920, the method of gaseous diffusion, which depends upon the direct relation between the mobility of the molecules and their mass had already been tried in 1913 with neon by F. W. Aston, and in 1919 with hydrogen and oxygen by O. Stern and M. Volmer. Aston's work, which was begun immediately after the complex nature of neon had been demonstrated by J. J. Thomson, after a long series of diffusions

weights 20.15 and 20.28 + 0.02 differing by - 0.25 per cent. 0 + 0.40 per cent. from the atomic weight of atmospheric neon (20.20). On the other hand the experiments of Stern and Volmer, who tried to decompose hydrogen and oxygen by diffusion, in the hope of explaining by isotopism the fractional value of the ratio of the atomic weights of these two elements, led to absolutely negative results, agreeing, moreover, with the data given by the method of mass-spectra. During the last two years the method in question has been applied to chlorine by W. D. Harkins and A. Hayes, to iodine by E. Kohlweiler, and to mercury by J. N. Bröusted and G. V. Hevesy.

The work of Harkins and Hayes was the continuation of a series of experiments begun in 1916 by the first of these authors, in collaboration with W. D. Turner, which experiments were interrupted during the last years of the war and were taken up again in 1919 with T. H. Liggett and C. E. Brocker. Except for some preliminary experiments in which chlorine commercial was used as material, the fractionation was performed with gaseous HCl, prepared by the action of sulphuric acid upon pure concentrated hydrochloric acid. The diffusion was carried out at atmospheric pressure, the gas being led into tubes of materials of different porosity. The apparatus finally employed enabled several thousands of litres to be diffused in a day. The course of the fractionation was followed by comparing the densities and molecular concentrations of the aqueous solutions of hydrochloric acid prepared with the original acid, and the acid which was obtained after diffusion. Each specimen of gaseous acid was submitted before examination to a complete purification by fractional distillation. The densities were determined by means of a quartz pycnometer of capacity 22 cc. placed after being filled in a thermostat regulated to about 0.001°. The balance used was sensitive to 0.02 mg. The molecular concentrations of the acid solutions were obtained by titration with one hundredth normal caustic soda (titration by weight). Three residues of diffusion were examined corresponding to 5.9 and 90 gr. of chlorine. The combining weight of chlorine was found to be 35.515 for the first residue (mean of five determinations), and 35.498 for the second, and 35.494 for the third. ... thus 0.155 per cent. 0.107 per cent., and 0.096 per cent. referred to the normal value, 35.46.

In the experiments of Kohlweiler relating to the separation of the hypothetical isotopes of iodine, it was not the residue after diffusion that was examined, as in Harkins' work, but the diffused fraction. Iodine vapour was passed into a glass tube kept at a temperature of 220° and having 16 partitions of porous material in the interior. Conveniently arranged absorbers, consisting of carbon disulphide, retained the fraction diffusing most rapidly and then the less dense. After 768 consecutive diffusions the lightest fraction was subjected to seven density determinations by Dumas' method. The density was found to be about 0.6 per cent. less than that of the vapour of ordinary iodine, determined in the same experimental conditions. According to the author, this result confirms his predictions relating to the existence of several isotopes of iodine. It must be noted, however, that according to Aston's observations, iodine is certainly not a complex element. Hence Kohlweiler's positive result should be regarded, provisionally at any rate, as doubtful.

In the attempts of Brinsted and v. Hevesy to separate the isotopes of mercury by fractional diffusion, the metal was heated to 105° in a glass bulb, the neck of which was connected with two test-tubes, one after the other, cooled by means of ice. The one nearest the bulb was closed at the top by a sheet of platinum pierced with a thousand holes of diameter 0.15 mm. The greater part of the mercury vapour condensed in the second test-tube, and only a small fraction in the first, after having diffused through the platinum sieve. Only one single series of experiments seems to have been carried out with this apparatus. The density of the diffused mercury was 0.0013 per cent. lower than that of the ordinary metal. This difference is very small, but the authors regarded their measurements of density as correct to 0.0001 per cent. approximately. We shall return to this point when discussing attempts to fractionate mercury by evaporated and rapid condensation, a method also employed by Brinsted and v. Hevesy.

(*To be continued.*)

PROCEEDINGS AND NOTICES OF SOCIETIES.

IMPORTANT NOTICE.

CHEMICAL SOCIETY.

Burlington House,
Piccadilly, W.1.

ROLL OF HONOUR.

In view of the preparation of the Roll of Honour, the Council desires to ensure that the names of all those Fellows who have been killed in action or who died on service should be included therein.

The following names are those so far received, and Fellows are invited to notify the Assistant Secretary by August 31st of any names that have been omitted.

Andrea Angel, (date of death) January 19th, 1917; John Percy Batey, April 9th, 1918; Charles Maurice Berlein, June 16th, 1915; Bertram Haward Buttle, October 1st, 1917; Norman Phillips Campbell, May 3rd, 1917; Frederic William Caton, June 28th, 1916; Cecil Reginald Crymbe, November 20th, 1914; John Llewellyn Davies, September 26th, 1915; Charles William Dick, November 9th, 1918; John Gunning Moore Dunlop, August 27th, 1914; Charles Geo. Edgar Farmer, August 14th, 1916; James Louis Foucar, May 8th, 1915; Edward William Lanchester Foxell, June 11th, 1917; Ivan Richard Gibbs, September 27th, 1915; Edward Frank Harrison, November 4th, 1918; John Maxwell Heron, March 26th, 1917; Charles Cochrane Iles, December 19th, 1914; Richard Arnold Seymour Jones, March 27th, 1915; Maurice Kemp-Welsh, April 11th, 1917; Herbert King, October 7th, 1917; Frank Stevenson Long, September 26th, 1915; James McConnan, December 20th, 1916; Cyril Douglas McCourt, October 8th, 1916; Raymond William Nichols, October 26th, 1916; Leonard Ison Pitt, July 30th, 1915; Benjamin Ashwell Posford, February 25th, 1915; William Gilbert Saunders, September 6th, 1916; Arthur Edwin Tate, April 22nd, 1917; Cecil Hamersley Waldron, March 2nd, 1916.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

GENERAL MEETING IN SHOWYARD.

Proceedings at General Meeting, held in the large tent in the showyard at Cambridge on Wednesday, July 5th, 1922, H.R.H. the Duke of York, K.G. (President), in the chair.

PRESIDENT'S OPENING REMARKS.

H.R.H. the Duke of York, in opening the meeting, said:—My Lords, Ladies and Gentlemen,—It is a great pleasure to me to be here in my position as President at the annual general meeting of the Royal Agricultural Society on the occasion of the annual show being held in my old university town. (Applause.) This is the third time the show has been held at Cambridge, and in this connection it is gratifying to note the wonderful increase, both in size and importance, both of the Society and of the show, since the first show took place here in 1840. (Hear, hear.) Without entering into too many details, the show has increased in extent from the 5 acres which it then occupied on Parker's Piece to over 120 acres on the magnificent site so generously placed at our disposal by my old College of Trinity. The prize money, from from the £900 of that date, has risen to the £13,800 which is being offered at this show, while the entries of live stock and implements have swollen to an amount which admits of no comparison with the two previous shows held in Cambridge. The most striking thing of all is the membership of the Society, which has increased from the 3,000 of the year 1840 to the wonderful total of 13,375. I hope that the mournful prophets who seek to impress upon us that British agriculture has had its day will read and realise the significance of these remarkable figures. Eighty-three "new implements" are entered for the Society's silver medal, and this, I think, reflects the greatest credit upon the inventive genius and progressive spirit of agricultural machinery manufacturers. This is all the more creditable considering the differences which have taken place in the engineering trade and the lack of demand by foreign countries for agricultural implements, which must have lessened the incentive for invention that is so necessary for the creation of anything which is new. I heartily congratulate the implement ex-

hibitors on the remarkable way they have overcome all these difficulties and on the assembly of such a wonderful show of machinery.

Turning to the live stock section, the recent outbreak of foot-and-mouth disease, which spread so rapidly throughout the country, must have caused the owners of valuable stock to think very seriously before deciding to send their animals to the show. Their courage is greatly to be admired, and I trust it has had its reward in the prizes gained by them in the various sections. The forestry, horticultural, education and bee sections are well represented. Therefore, in spite of the difficulties, to which I have alluded, in the implement and live stock sections, the Cambridge Show has created a record of entries, and the Society and exhibitors are greatly to be congratulated on the fact that the show promises to be a most successful one.

As on former occasions, the county, the town, and the University have vied with each other in giving to the Society a very cordial welcome. Resolutions will be submitted to you tendering the thanks of the Society to the various bodies which have contributed so largely to the success of the show, and they will, I feel sure, meet with your cordial approval. I cannot, however, allow this opportunity to pass without referring to the vast amount of work which your Honorary Director, Sir Gilbert Greenall—(applause)—has done in the preparation, organisation and administration of this show, and to his expert knowledge and untiring energy. In the name of the Society I would like to thank him.

THE BOROUGH POLYTECHNIC INSTITUTE, BOROUGH ROAD, LONDON, S.E.1.

Chemistry Department.

Session, 1922-23, commencing Monday, 25th September, 1922. Enrolment nights for all departments: Monday, Wednesday, and Friday, 18th, 20th, and 22nd September.

Special arrangements have been made for courses for students who wish to work for the National Certificate in Chemistry, sanctioned by the Board of Education and the Institute of Chemistry. The course of [illegible] will be given this session by Mr. A. E. Parkes, F.I.C., formerly chief chemist to Messrs. Lipton, Ltd.

Afternoon classes in Chemistry applied to the laundry industry.

For further particulars apply to the Principal.

IRON AND STEEL INSTITUTE.

President: Dr. J. E. Stead, F.R.S.

York Meeting, September 5th to 8th, 1922.

A full programme of events has been arranged, particulars of which can be obtained from the Secretary, 28, Victoria Street, S.W.

The following is the list of papers which it is expected will be submitted at the meeting:—

L. Aitchison: *The Changes of Volume of Steels During Heat Treatment. 1: Air Hardening Nickel Chromium Steels*).

L. E. Benson: *Nitrogenisation of Iron and Steel by Sodium Nitrate.*

E. D. Campbell: *A Brinell Machine Attachment for Use with Small Specimens.*

E. D. Campbell and — Johnson: *A Preliminary Magnetic Study of Some Heat-treated Carbon Steels.*

J. H. S. Dickenson: *Some Experiments on the Flow of Steels, at a Low Red Heat, with a Note on the Scaling of Heated Steels.*

C. W. H. Holmes: *An Investigation on the Factors Influencing the Grain and Bond in Moulding Sands.*

H. K. Ogilvie: *Practical Notes on the Manufacture and Treatment of High-speed Steel.*

A. K. Reese: *The Bases of Modern Blast Furnace Practice.*

G. A. V. Russell: *Reversing Cogging Mills: Their Drives and Auxiliary Equipment.*

J. H. Whiteley: *The Diminution of Lag Ar 1 through Deformation.*

Members who desire to receive advance copies of any of the papers should make early application for them. Those who wish to attend the meeting should preserve their copies, as it may not be possible to supply additional copies at the meeting. It will oblige if members will limit their requests for papers to those only in which they are particularly interested.

THE INSTITUTE OF METALS

AUTUMN MEETING, SWANSEA, SEPTEMBER 19TH TO 22ND, 1922.

A very full programme of events has been arranged for each day, particulars of which can be obtained from the Secretary, 36, Victoria Street, London, S.W.1.

The following communications are expected to be submitted:—

Sixth Report to the Corrosion Research Committee of the Institute of Metals on *The Nature of Corrosive Action, and the Function of Colloids in Corrosion*. By GUY D. BENGOUGH, M.A., D.Sc., and J. M. STUART, M.A.

A Report to the Aluminium Corrosion Research Sub-Committee of the Corrosion Research Committee of the Institute of Metals on *Experiments on the Oxide Method of Determining Aluminium*. By J. E. CLENNELL, B.Sc.

PROFESSOR J. H. ANDREW, D.Sc. (Glasgow) and ROBERT HIGGINS (Glasgow), on *Grain-Size and Diffusion*.

F. L. BRADY, M.Sc. (Birmingham), on *The Structure of Eutectics*.

MAURICE COOK, M.Sc. (Cambridge), on *The Antimony-Bismuth System*.

SIR HENRY FOWLER, K.B.E. (Derby). Note on *The Effect of Superheated Steam on Non-Ferrous Metals used in Locomotives*.

MARIE L. V. GAYLER, M.Sc. (Teddington), on *The Constitution and Age-Hardening of Alloys of Aluminium with Copper, Magnesium, and Silicon in the Solid State*.

F. W. HARRIS, M.Sc. (Teddington), on *The Hardness of the Brasses and some Experiments on its Measurement by Means of a Strainless Indentation*.

A. JEFFERSON (for the Sheffield Silver Trades Technical Society). Note on *The Cause of Red Stains on Silver-Plated Work*.

F. JOHNSON, D.Sc. (Birmingham), and W. GRANTLEY JONES (Birmingham), on *New Forms of Apparatus for Determining the Linear Shrinkage and for Bottom-Pouring of Cast Metals and Alloys, accompanied by Data on the Shrinkage and Hardness of Cast Copper-Zinc Alloys*.

Q. A. MANSURI, B.A., M.Sc. (Cambridge), on *Intermetallic Actions. The System Thallium-Arsenic*.

A. H. MUNDEY (London), C. C. BISSETT, B.A., B.Sc., B.MET. (London), and J. CARTLAND, M.C., M.Sc. (Manchester), on *White Metals*.

W. ROSENHAIN, D.Sc., F.R.S. (Vice-President), and J. D. GROGAN, B.A. (Teddington), on *The Effects of Overheating and Melting on Aluminium*.

R. SELIGMAN, PH.NAT.D. (Member of Council), and PERCY WILLIAMS, B.Sc. (London). Note on *The Cleaning of Aluminium Utensils*.

D. STOCKDALE, B.A. (Cambridge), on *The Copper-Rich, Aluminium-Copper Alloys*.

Only members and student members will be entitled to participate in the Swansea meeting. For the convenience of applicants for membership who are desirous of being elected in time for the meeting, a special ballot is being arranged in connection with which membership application forms should be received by the Secretary not later than noon on Thursday, September 7th. The ballot will be concluded in time for members and student members so elected to participate in the meeting.

GENERAL NOTES.

PARLIAMENTARY INTELLIGENCE.

ARSENIC AND STRYCHNINE.

Sir Fortescue Flannery asked the Minister of Health if his attention had been called to the suggestion of one of His Majesty's judges that poisons in the form of powder, such as arsenic and strychnine, should be manufactured and sold only with distinctive colouring, and that white strychnine or arsenic podwers should be no longer permitted; and whether the Government would introduce legislation to give effect to these suggestions.

Mr. Shortt, Home Secretary, replied: Yes, sir, inquiries are being made as to the practicability of employing distinctive colours for poisons. The investigation is not yet complete.

DYESTUFFS.

Mr. Galbraith asked the President of the Board of Trade whether any arrangements were being made or contemplated whereby

all profits made by the central importing agency out of the sales of German reparation dyestuffs on behalf of the Government were to be handed over to British dye makers.

Sir P. Lloyd Greame replied: No arrangements of the kind suggested have been made. Certain proposals for the assistance of the dye-making industry as a whole by the further co-operation of the dye-users and the State have, however, been tentatively put before the President of the Board of Trade, and he is in consultation with the Chancellor of the Exchequer on the subject.

SODIUM PYROPHOSPHATE.

Mr. Kiley asked the President of the Board of Trade if he was aware that one of the largest makers of patent food products, employing a considerable number of hands, who were large consumers of sodium pyrophosphate (cream of tartar substitute), a product scheduled in the key list under Part I. of The Safeguarding of Industries Act, 1921, were unable to meet competition for export business of foreign makers of similar products who obtained this raw material free of any duty, and was also handicapped in the home market by competitive firms consuming cream of tartar, a similar product which had been taken out of the key list by order of the referee, and in consequence had had to curtail their output and discharge a large number of workmen; and, if so, how much longer was it intended to levy duty on the imports of sodium pyrophosphate and hundreds of other articles which, on the referee's rulings on points of principle, were clearly outside the scope of Part I. of the Act?

Sir P. Lloyd Greame replied: No representations have been made to me that the action taken by the Board of Trade on the decision of the referee in the case mentioned has had any effect on the export trade of any company, or has curtailed output and caused unemployment. As regards the last part of the question, I am not aware of any decisions of the referee which would warrant the assumption made by the hon. member.

ANALYTICAL RE-AGENTS.

Mr. Hogge asked the President of the Board of Trade whether he was aware that, in the Safeguarding of Industries Act, 1921, certain heavy chemicals never intended to be taxed had to be taxed because they were used in comparatively minute quantities as analytical re-agents; that, in consequence, such a heavy chemical as hyposulphite of soda was taxed because a few hundred pounds, as compared with every 1,000 tons used industrially, was used as an analytical re-agent; whether he was in sympathy with this unexpected result of the Act; and, if not, what steps, if any, he proposed to take.

Sir P. Lloyd Greame replied: Such heavy chemicals as are prepared in a very high degree of purity for use as analytical re-agents are liable to duty only when of analytical re-agent or correspondingly special quality. As regards the second part of the question, hyposulphite of soda of the ordinary industrial grade is not liable to duty, but only the photographic quality. This is not an unexpected result of the Act, and consequently I do not propose to take any action in the matter.

TECHNICAL RECORDS OF EXPLOSIVES SUPPLY, 1915-18. No. 7.

MANUFACTURE OF NITRIC ACID FROM NITR AND SULPHURIC ACID.

A special series of reports is being pul lished for the Department of Scientific ar Industrial Research in order to make avai able, for the benefit of the industries co cerned, results of scientific and industri value contained in the technical records the Department of Explosives Supply the Ministry of Munitions. The work r corded was done at or in connection wi some of the National Factories during t war. The preparation of the necessary a stracts of information was begun by t Ministry of Munitions at the close of t war, and arrangements were afterwa made by the Department of Scientific a Industrial Research to complete them.

The present report embodies the resu of very careful study and investigation the conditions for working to the b advantage large-scale plant for the p duction of nitric acid from nitre and phuric acid. The subject is dealt w under the following sections:—

SECTION 1.—*Description of Plant Process for Manufacture of Nitric Acid Retort Process*: General outline; des

tion of buildings and plant; plant operation; standardisation of retorts; desiderata in running the retort house; standard retort charges; diagram for use in charging nitric acid retorts; composition of the sodium nitrate used; determination of conditions for maximum output, condenser efficiency, &c.; summary of conclusions, and further trial run; further report on nitric acid plant with Hart condensers; thermal equilibrium in nitric acid manufacture by retort process; cracking of retorts.

SECTION 2.—*Nitric Acid Stills for Distillation of Spent Acid from the Manufacture of Nitro-cotton*: Discontinuous distillation; continuous distillation.

SECTION 3.—*Description of Plant and Process for Washing Nitre Bags*: General outline; description of plant; operation of plant; steam consumption; quantities dealt with; labour requirements; improved practice in bag-washing; outlines of a model bag-washing plant; cost of running nitre bag-washing plant.

The report described below has been published by His Majesty's Stationery Office for the Department of Scientific and Industrial Research. Copies, price 10s. 6d. (by post 11s.), may be obtained through any bookseller, or direct from H.M. Stationery Office.

FACTORY AND WORKSHOP.

DANGEROUS AND UNHEALTHY INDUSTRIES.

"The Chemical Works Regulations, July 11th, 1922, made by the Secretary of State under Section 79 of the Factory and Workshop Act, 1901 (I. Edw. 7, C.22) to apply to the manufactures and processes incidental thereto carried on in Chemical Works."

Printed and published by His Majesty's Stationery Office, to be purchased through any bookseller or directly from H.M. Stationery Office at the following addresses: Imperial House, Kingsway, London, W.C.2, and 28, Abingdon Street, London, S.W.1; 37, Peter Street, Manchester; 1, St. Andrew's Crescent, Cardiff; and 23, Forth Street, Edinburgh.

PAPER-MAKERS' DIRECTORY OF ALL NATIONS.

DEAN & SONS, LTD., DEBRETT HOUSE, 29, KING STREET, COVENT GARDEN, LONDON, W.C.2. PRICE 21/-.

The 31st Annual issue of this Directory has recently been published. It is a very carefully arranged volume of 950 pages, and contains all that there is to be known of the world's production of paper. It will be found of great value to all engaged in paper production and the allied trades. Much care appears to have been taken in the arrangement of the various sections of the work—these are arranged in alphabetical order. The publishers are to be congratulated upon having secured such a volume of information during the present period of commercial distraction, and as there appears to be sure hope of an early improvement the new edition is likely to be in great demand.

RECORD OF PHOTOGRAPHY.

ISSUED BY THE PROFESSIONAL PHOTOGRAPHERS' ASSOCIATION OF GREAT BRITAIN AND IRELAND.

We have received a copy of the first issue of the above, together with two remarkably good photographs, one of Pirie Macdonald, and the other of Bairnsfather.

In a foreword by the Editors, George Hand, Marcus Adams, and Jenkyn Griffiths, it is explained that the chief object of the publication is to cater for the wants of the professional photographer, and to increase the membership of the Professional Photographers' Association. The issue contains a deal of interesting information, together with a full account of the proceedings of the Council of the P.P.A. The Secretary, Mr. Alfred Ellis, Professional Photographers' Association of Great Britain and Ireland, Ltd., 2, Vinery Villas, London, N.W.8, will be pleased to send particulars of membership on application.

New Patents.

This list is specially compiled for *Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

19821—British Oxygen Co., Ltd.—Manufacture of sulphur dioxide. July 19.
19533—Chapman, E. B.—Catalyst strainers. July 17.
19553—Davis, J.—*Oxy-chloride cement coverings.* July 17.
19703—Johnson, J. Y.—Production of metaldehyde and obtainment of combustible substances thereof. July 18.
19546—Johnson, W.—Machine for drying and neutralising sulphate of *ammonia. July* 18.

Specifications Published This Week.

155776—Brutzkus, M.—Process for effecting chemical reaction in the interior of compressors.
159878 Norsk Hydro-Elektrisk Kvaelstof-aktieselskab.—Process for the manufacture of *ammonia.*
182609—Burgess, L.—Process of reducing aluminium oxide.
165083—Farbenfabriken vorm. F. Bayer & Co.—Manufacture of new copper compounds substantive azo-dyestuffs.
182693—*Hetherington, H.—Manufacture of lead* chromate pigments.
172937—Barret Co. Process for the purification of naphthalene.

Abstract Published This Week.

Lead Azide.—Patent No. 180605.—A process for obtaining lead azide, particularly for use in explosion composition, has been devised by Mr. W. Friederich, of Troisdorf, near Cologne, Germany, and patented in this country. It is obtained in mixed or double crystals with other substances such as basic lead azide, heavy metal hydroxides, carbonates, basic chlorides, and sulphates, and neutral and basic salts of nitrocompounds, for example, mono-di-and trinitrophenols, di-and trinitroresorcin, trinitrophloro-glucinol, trinitroaminophenol, metadintroorthodinitrosobenzol, and hexanitrodiphenyl amine. The double crystals may be obtained by simultaneous or successive precipitation.

Messrs. Rayner & Co. will obtain printed copies of the published specifications, and forv post free for the official price of 1s. each.

City of Cardiff Education Committee.

THE TECHNICAL COLLEGE.
Principal: Charles Coles, B.Sc. (Lond.).
DEPARTMENT OF INDUSTRIAL CHEMISTRY.
Head of Department: H. W. Webb, M.Sc., F.I.C., F.C.S.
Session 1922-23.
(Commencing on Tuesday, 3rd October, 1922).
Joint Course
(with University College of South Wales and Monmouthshire).

A COMPLETE COURSE in CHEMISTRY *and* Associated Subjects *is* provided *for* those wishing to become industrial chemists. The Course includes:—

Chemistry, Physics, Mathematics, Chemical Engineering, Utilisation of Steam and Electric Power, Cost Accounting, together with a specialised practical training in a branch of industrial chemistry chosen from the following:—

(1) Fuel.
(2) General Iron and Steel Manufacture.
(3) Gas manufacture.
(4) Foundry work.
(5) Tin-plate manufacture.
(6) Refractories and Cement.
(7) Electro Chemistry.
(8) Brewing.
(9) Paper-making.

Examinations which are also catered for by the Course include:—
B.Sc. (Lond.) Ext.
Associate Institute of Chemistry.
F.I.C. in Chemical Engineering.

A number of Part-Time Courses are also available to cover requirement of work's Chemist, and those of various public examinations.

For further particulars of Full-Time and Part-Time Courses, Entrance Examination, *Scholarships, Fees, etc., apply to the* Principal. Forms of application for admission to the Entrance Scholarship Examination, duly completed, must be received by the 18th September.

JOHN J. JACKSON,
Director of Education,
City Hall, Cardiff.

THE CHEMICAL NEWS,

VOL. CXXV., No. 3254

A NEW PHYSICO-CHEMICAL LAW.

By Hawksworth Collins.

(*Continued from Page* 83.)

The volume of the radical CO_3 is 20.55, which splits up into 8+7.53+2(2.51), where 8 is the volume of the carbon atom. The corresponding H.F. is 210765, which splits up into −13886+32341+2(96155). (See Table VII. for the explanation of −13886.)

It is evident from Tables III. and VII. that whenever the change of volume is negative, the H.F. is positive, and *vice versa*. This is true in every case investigated, without any exception.

This regularity alone makes it absolutely certain that the heat of formation is entirely due to change of volume; *i.e.*, when the volume of an element in combination is less than its original volume in the solid state, heat of formation is given out, and *vice versa*.

It would have been impossible to make this discovery if the three relative volumes of Oxygen had not previously been found, the details of which were sent to the Nobel Institute in 1914.

This matter affords another instance of the reason for the claim that the relative volumes are the fundamental constants of Nature.

Table III.

		Original Relative Volume	Rel. Vol. in combination	Change of Volume	Heat of Formation
1.	Pb	18.17	17.42	−0.75	+ 18500 = 120 × 0.75 × 206
2-3.	Pb	18.17	19.39	+1.22	− 30200 = 120 × 1.22 × 206
4.	Pb	18.17	19.81	+1.64	− 40607 = 120 × 1.64 × 206
5-7.	Sb	17.91	21.29	+3.375	− 48200 = 120 × 3.375 × 119
8-9.	Zn	9.62	11.53	+1.91	− 14900 = 120 × 1.91 × 65
10.	Zn	9.62	12.6	+2.98	− 23223 = 120 × 2.98 × 65
11.	Cu	7.08	9.05	+1.97	− 14907 = 120 × 1.97 × 63
12.	Cu	7.08	9.74	+2.66	− 20083 = 120 × 2.66 × 63
13.	As	15.69	19.58	+3.89	− 35000 = 120 × 3.89 × 75
14.	Mo	11.11	15.53	+4.42	− 50900 = 120 × 4.42 × 96
15.	Hg	14.65	17.05	+2.4	− 57400 = 120 × 2.4 × 199
16.	Hg	14.65	16.62	+1.97	− 47000 = 120 × 1.97 × 199
17.	Bi	21.29	24.29	+3.0	− 75200 = 120 × 3.0 × 209
18-19.	Na	23.7	11.85	−11.85	+ 32706 = 120 × 11.85 × 23
20-22.	Fe	6.95	11.65	+4.7	− 31570 = 120 × 4.7 × 56
21.	Fe	6.95	10.08	+3.125	− 21000 = 120 × 3.125 × 56
23-24.	Sn	16.1	18.08	+1.98	− 28040 = 120 × 1.98 × 118
25.	Cd	12.83	14.57	+1.74	− 23200 = 120 × 1.74 × 111
26.	Cd	12.83	15.16	+2.33	− 31000 = 120 × 2.33 × 111
25.	Se	16.27	11.25	−5.02	+ 47045 = 120 × 5.02 × 78
27-28.	Cr	7.12	8.78	+1.66	− 10364 = 120 × 1.66 × 52
29-30.	Ca	25.66	12.24	−13.42	+ 64420 = 120 × 13.42 × 40
31-32.	Ca	25.66	13.25	−12.41	+ 59568 = 120 × 12.41 × 40
33.	Ca	25.66	14.33	−11.33	+ 54376 = 120 × 11.33 × 40
34.	Ni	6.72	8.13	+1.41	− 10000 = 120 × 1.41 × 59
35.	Co	6.8	11.45	+4.65	− 32920 = 120 × 4.65 × 59
36-37.	Ag	10.1	13.61	+3.51	− 45080 = 120 × 3.51 × 107
37.	Ag	10.1	10.25	+0.15	− 1900 = 120 × 0.15 × 107
38.	Ce	21.12	19.20	−1.92	+ 32290 = 120 × 1.92 × 140
39	Si	11.59	18.91	+7.32	− 24600 = 120 × 7.32 × 28
40.	W	10.17	12.89	+2.72	− 60060 = 120 × 2.72 × 184
41.	Ta	17.928	21.98	+4.052	− 88500 = 120 × 4.052 × 182
42.	Th	21.49	13.62	−7.87	+219000 = 120 × 7.87 × 232

TABLE IV.

		Original Relative Volume	Theor. S.G.	Observed S.G. & Observer.
1-4.	Pb	18.17	11.34	11.33 Kupffer 11.346 Crichton
5-7.	Sb	17.91	6.65	6.646 P & J 6.675 Spring
8-10.	Zn	9.62	6.76	6.512 P & J 6.939 P & J
11-12.	Cu	7.08	8.89	8.895 Hatchett
13.	As	15.69	4.78	4.71 Bettendorff 4.91 Spring
14.	Mo	11.11	8.64	8.636 Bucholz 9.01 CK
15-16.	Hg	14.65	13.584	13.584 16°-6 Stewart
17.	Bi	21.29	9.82	9.82 Roberts & Wrightson
18-19.	Na	23.7	0.97	0.97 Troost & Hautefeuille
20-22.	Fe	6.95	8.06	8.007 10° Schiff (reduced by H)
				8.139 15°.5 Smith (electrolytic)
23-24.	Sn	16.1	7.34	7.3395 Baudrimont
25-26.	Cd	12.83	8.655	8.655 11° Matthiessen
25.	Se	16.27	4.8	4.8 Rathke
27-28.	Cr	7.12	7.3	7.3 Bunsen
29-33.	Ca	25.66	1.56	1.566 Matthiessen 1.55 Jobin
34.	Ni	6.72	8.78	8.713 Baumgarten 8.88 Arndtsen
35.	Co	6.8	8.68	8.558 Henry 8.71 Lampadius
36-37.	Ag	10.1	10.6	10.621 0° Quincke 10.575 Christomanos
38.	Ce	21.12	6.628	6.628 Hillebrand & Norton
39.	Si	11.59	2.416	2.337 Miller 2.48 m of 6 Playfair
40.	W	10.17	18.09	17.9 - 18.12 Bernouilli
41.	Ta	17.928	10.15	10.08 - 10.78 Rose
42.	Th	21.49	10.8	10.968 Nilson

TABLE V.

		Rel. Volume.	Theor S.G.	Observed S.G. & Observer
43.	B_2O_3	2(15.17)+3(2.51)	1.848	1.753-1.83 V N
44.	B_2S_3	2(15.17)+3(15.53)	1.534	1.55 V N
45.	BBr_3	15.17+3(27)	2.61	2.65 0°/4 V N ∴ 2.63 15°
46.	LiCl	6.21+15.085	1.996	1.998 Kremers
47.	LiF	5.46+5.33	2.41	2.295 21° Clarke 2.54 C K
48.	Li_2S	2(5.46)+15.53	1.74	1.63-1.7 V N

TABLE VI.

		Theoretical Heat of Formation.			Observed H.F.	
43.	B_2O_3	-2(7800)+3(96155)	=	272865	272600	
44.	B_2S_3	-2(7800)+3(30681)	=	76443	75800	
45.	BBr_3	-7800+3(17000)	=	43200	43200	
46.	LiCl	38416+56132	=	94548	93900	93810 T
47.	LiF	42570+76820	=	119390	120000	
48.	Li_2S	2(42570)+30681	=	115821	115400	

TABLE VII.

		Original Relative Volume	Rel. Vol. in combination	Change of Volume	Heat of Formation						
43-45.	B	14.728	15.17	+0.892	- 7800	=	795	×	0.892	×	11
	C	6.544	8	+1.456	-13886	=	795	×	1.456	×	12
	O	10.07	7.53	-2.54	+32341	=	795	×	2.54	×	16
	O	10.07	4.45	-5.62	+71515	=	795	×	5.62	×	16
	O	10.07	2.51	-7.56	+96155	=	795	×	7.56	×	16
46.	Li	13.11	6.21	-6.9	+38416	=	795	×	6.9	×	7
47-48.	Li	13.11	5.46	-7.65	+42570	=	795	×	7.65	×	7
	F	10.38	5.33	-5.05	+76820	=	795	×	5.05	×	19

TABLE VIII.

		Orig. Rel. Vol.	Theor S.G.	Observed S.G. & Observer.
43-45	B	14.278	0.77	?
	C	6.544	1.834	1.84 Griffith 1.80 Playfair (charcoal)
46-48	Li	12.1	0.578	0.578 Bunsen

Lithium is not quite in accordance, unless its S.G. is 0.534, which gives rel. vol. 13.11.

ALUMINA.

Hydrolysis of Aluminum Salts.

By Wilder D. Bancroft.

(From the Journal of Physical Chemistry, June, 1922.)

(Continued from Page 86.)

Very recently Tingle[1] has claimed that alumina is not adsorbed by cellulose either from aluminium sulphate or basic aluminum sulphate solution. The first statement is not new, and the second is probably not correct as a general one, though it may be true for the particular experimental conditions. There is nothing to show that Tingle appreciated the necessity of having peptized alumina in his solution or that he did have it.

Aluminum acetate is usually used for mordanting cotton both in dyeing and printing. "The most common, and we believe the best method of using alumina as a mordant for cotton, is by substituting acetic acid for sulphuric acid in combination with it. The acetate of alumina has several advantages over the sulphate: 1st, the acetic acid is not so hurtful in its action upon the vegetable colouring matters; 2nd, it holds the alumina with much less force than sulphuric acid, and consequently yields it much more freely to the cloth; and 3rd, being volatile, a great portion of the acid flies off during the process of drying. When strong colours are wanted, and the mordant is of such a nature as will admit of being dried, it is better to dry the cloth from the mordant previous to dyeing. This last property of acetic acid is, therefore, very convenient, as it frees the cloth from any superfluous acid which may have been in the mordant; besides, it has been found that during the drying by heat, the soluble acetate is converted into a less soluble subacetate. We may here put the dyer in mind that when goods containing volatile acids are drying, no other kind of goods should be allowed to be in the same apartment, as the acid will be absorbed by them ,and will affect almost any colour that either has been or may be put upon them. Many unpleasant and also expensive consequences occur from the neglect of these precautions."

1 *Jour. Ind. Eng. Chem.*, 14, 198 (1922).
2 *Napier*: "*A Manual of Dyeing*," 121 (1875).

Bancroft[1] gives an interesting account of the early use of aluminum acetate in calico printing. "By thus substituting the acetic for the sulphuric acid, in the aluminous mordant lately described, several considerable advantages are gained. The acetate of alumina being much more soluble in water than common alum, the liquor will contain a much larger proportion of alumine than could be otherwise suspended in it; and with this advantage, moreover, that it will not be liable to form crystals in or upon the linens or cottons in drying, as would happen with a solution of common alum, the acetate of alumina being incapable of crystallisation. I may add also that the acid of vinegar being volatile, and having a much weaker attraction for its earthy basis than the sulphuric acid has, the former will be speedily separated and carried off, especially by the heat of the stoves employed for drying the pieces printed with it, and will leave behind the alumine which it has dissolved, and which, being no longer encumbered by any other attraction, will yield itself wholly to that, which subsists between it, and the fibres of linen or cotton, and will unite with them more copiously and firmly than it otherwise could do, and be thereby enabled more strongly to attract and fix the colouring matters in the dyeing vessel. This, however, will only prove true, so far as the sulphate of alumina has been really decomposed by the acetate of lead, or so far as the alumina has been combined with the acetic instead of the sulphuric acid.

"As the practice of calico-printing has been but lately introduced into Europe, and as the acetic aluminous mordant does not appear to have been previously known in any other country, we might have expected that its discovery in this would have been deemed a matter so important as to have constituted an area in the history of art; and, therefore, I was not a little surprised in finding that no writer had mentioned, and that no calico-printer, of whom I have inquired, could inform me, at what time, or by whom, this mordant was first employed, as the basis of red and yellow colours in calico-printing. My wonder has, however, ceased on this subject, since I have inspected a considerable number of recipes for making the several mix-

1 "*Philosophy of Permanent Colours*," 1, 365 (1813).

tures employed as mordants, soon after the business of calico-printing began to be carried on with some degree of success here, and in other parts of Europe. In one of these, which seems to have been the earliest, alum, sal ammoniac, saltpetre, red orpiment, and kelp, were directed to be mixed with water. In another, which probably followed this, it was directed that these ingredients should be dissolved in vinegar. In a succeeding recipe, a little sugar of lead was directed to be employed, but in a quantity too small to be of any considerable use; I mean one ounce of it for every pound of alum. Afterwards, the calico-printers, without any system or reasonable motive, appear in different instances to have added verdigrise, arsenic, corrosive sublimate, blue vitriol, litharge, and white lead. By stumbling upon the two last (which alone were of any use), it happened, where vinegar had been also employed, as it commonly was in some shape, that after a variety of decompositions and recompositions, some portion of acetate of alumina was formed, the good effects of which were experienced, though without any true knowledge of the ways and means by which they have been produced. By degrees, however, the printers seem to have increased the quantity of sugar of lead, and several of them to have suspected that many of the other ingredients usually employed for making their mordants were useless. Some of them, therefore, began to omit one, and some another of these ingredients, until at length all the useless ones were laid aside, though without the aid of any chemical reasoning on the subject, and without any one having ever suspected, as indeed few of them do at this day, that the lead which they continued to employ occasioned any decomposition of the alum, or that the mordant so produced did not really contain all the lead and other ingredients used to prepare it. Among the useless ingredients before mentioned, corrosive sublimate seems to have been retained the longest, since Mr. Wilson includes it in his recipe, which was published so lately as the year 1786.

"It is not wonderful, therefore, that no particular person or period has been noted, or remembered, as distinguishable for the first invention of the acetated aluminous mordant: since the sugar of lead, or other means of forming it, were at first used by *chance so sparingly, as to have scarcely produced any better effect than would have resulted from the mere solution of alum,* and the alterations and improvements by which the mordant afterwards acquired its present form, I had almost said perfection, were made by such imperceptible gradations, and resulted so much from the random additions and omissions of different individuals (no one of whom seems to have been guided by anything approaching to a just theory), that neither the discovery nor any considerable step towards it, can properly be referred to any one person or period.

(To be Continued.)

NOTE ON THE INHIBITORY EFFECT OF URINE ON THE PRECIPITATION OF UREA BY NITRIC ACID.

By Emil A. Werner, M.A., Sc.D.

Normal urine contains a little more than 2 per cent. of urea, yet when mixed with an equal volume of colourless strong nitric acid there is no precipitation of urea nitrate, even after the mixture has been cooled to 0° C., or allowed to remain in the cold for twenty-four hours.

A similar experiment made with an aqueous solution of urea gave the following result:—

(1) An equal volume of colourless nitric acid ($D = 1.42$) was added to 10 cc. of a 2 per cent. aqueous solution of urea. The liquid was cooled under tap-water. Urea nitrate commenced to separate after about three minutes. After twenty minutes the precipitate, which had been collected and well washed with ether, was titrated with N/10 NaOH. The weight of urea precipitated as nitrate was 0.1182 gram., equal to 59.1 per cent. of the total present.

(2) From a 4 per cent. solution of urea, treated in this way, 0.292 gram. was precipitated as nitrate, equal to 73.73 per cent. of the total amount of urea present.

On the other hand, when 2 grams of urea were dissolved in 100 cc. of a sample of normal urine (which contained 2.01 per cent. of urea), the weight of urea precipitated as nitrate from 10 cc. of the solution was 0.18 gram., as the mean result of three experiments. This equals 44.8 per cent. of the total amount present. Compared with

the result of the preceding experiment, it will be seen that in the presence of urine the amount of urea precipitated as nitrate was nearly 29 per cent. less (73.73 - 44.8 = 28.93) than in the plain aqueous solution containing the same concentration of urea.

The following result goes to show that the colloidal matter present in urine is no doubt responsible for the effect. A 2 per cent. solution of urea, in which 0.5 per cent. of gelatine had been dissolved, was treated as in experiment (1), 28.5 per cent. of the urea was precipitated as nitrate, *i.e.*, 59.1 - 28.5 = 30.6 per cent. less of the urea was precipitated than in the plain aqueous solution.

Considering the small proportion of colloidal matter which is believed to be present in urine, its inhibitory effect on the precipitation of urea nitrate is rather remarkable. The writer is not aware that attention has been previously drawn to this property of urine.

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Trinity College, Dublin.

RUDOLPH MESSEL.

From the First Messel Memorial Lecture delivered at the Forty-first Annual Meeting of the Society of Chemical Industry at Glasgow, July 4th, 1922, by Professor Henry E. Armstrong, F.R.S..*

I first met him in my initial year of office as a Secretary of the Chemical Society in April, 1876, on the evening when Dr. Squire and he described and demonstrated the process they had developed of manufacturing sulphuric anhydride, already in operation at Silvertown. He was elected a Fellow of the Chemical Society that same evening. I was the only speaker to break the harmony of the meeting by suggesting that Nordhausen sulphuric acid was not a mere solution of the anhydride but mainly a definite acid, a compound of the anhydride with sulphuric acid, anhydrosulhpuric acid, then unrecognised except by Schützenberger. I trod on Messel's heels with a paper on "Systematic Nomenclature"; this, too, shadows me to-day.

I was greatly attracted to him from the beginning, and we soon became fast, I may say affectionate, friends. Perhaps I surprised him by knowing the work he had done as a student on strychnine and maleic acid: I would here emphasise the fact that he started his career as a chemist on the organic side. Moreover, I had been ahead of him in cultivating the acquaintance of sulphuric anhydride—on German soil—as it was the subject of my Ph.D. thesis, published in English in the *Proceedings of the Royal Society*, under Frankland's patronage, in May, 1870, under the modest title, "Contributions to the history of the acids of the sulphur series. 1. On the action of Sulphuric Anhydride on several chlorine and sulphur compounds." This was my introduction to the Royal Society. A little later, in 1871, I made my first appearance, as an independent worker, at the Chemical Society, with a paper on the use of sulphuric chlorhydrol as a sulphonating agent. Messel was afterwards led to take an interest in this compound through preparing it for me.

I thus came under thionic fascination at an early stage of my career, and was fully prepared to appreciate Messel's work and its value, the more as I had worked alongside Graebe in Leipzig and Perkin was my fellow secretary.

Messel was born January 14, 1847, in Darmstadt. He died April 18, 1920, at his chambers in Victoria Street, London. He was of Jewish extraction, but professedly Lutheran.

To-day I will give only a brief survey of his history, sufficient to make clear his proclivities and the influences to which he was subject.

His father, Simon Messel, was not originally intended as his father's successor in the banking business, but was apprenticed to a Parisian maker of artistic furniture, which accorded more with his own taste for art. The interest of this fact lies in the indication of the source of the highly developed artistic tastes which most of his children evinced. Before he had completed his training in Paris, however, Simon Messel was recalled to Darmstadt to take the place assigned to his elder brother, who had journeyed to America and there disappeared from the sight of his relatives. In consequence of this change, Rudolph Messel's early years were spent in what for those days ranked as affluence, and his father was able to provide adequately for his education. He was the second of five children, of whom four were to make their homes in England; the fifth

acquired great distinction as an architect in Berlin.

He received his elementary training at Schmidtz's Academy in his native city. Shortly after his father's death in 1859 he was sent to a Huguenot school at Friedrichdorf in the Taunus, where he remained until early in 1863, that is to say, until he was fifteen years old. His early interest in science and his precocity are shown by the following reference he made to this period in his Presidential Address to this Society in New York in 1912:—

> "In 1861, when I was at school at Friedrichsdorf, in Germany, my master, Philip Reis, invented the first telephone. I was present at its birth, and assisted Reis in making the mechanical parts of some of his instruments and also repeatedly in his experiments, Reis being at one end of the circuit, speaking or singing, I listening at the other, or *vice versa*."

While he was at school, the family circumstances had changed, and it was clear that Messel would have to be self-supporting at an early date. His intention, formed during the last years at school, was to become an engineer, either civil or mechanical. In January, 1863, he discussed his future course of action with an old friend of his father's, Heribert Rau, an author of some distinction, then living in Frankfort. Rau wrote to him a letter strongly advising against this choice of a profession, basing himself upon the fact that the demand for engineers already fell short of the supply, whilst the boy's religion would, he said, militate against his receiving a State appointment. If the boy were father to the man, as all accounts indicated that he was, Rau knew well the love of independence and self-reliance which were among his young friend's salient characteristics. After citing the reasons given above, he lays the greatest stress upon the fact that to become an engineer would entail many years of study, preceded by years of practical work at the bench, so that the day when he would be able to support himself must be far distant. He then gives the young Rudolph positive advice, which it is clear determined all his future. He bids him devote himself to the study of commerce, which, he said, would rapidly lead to independence, and to combine with this the study of Chemistry, Physics and Technology, and so become a manufacturer. Rau seems to have felt that to become a manufacturer was a great falling away from grace for an ardent boy, because he goes at great length into the great future which lies before him, and the noble examples of enlightened and well-spent lives which were to be found among the great manufacturers of the day. Finally, he advises Messel to move to Frankfort, to enter the business of some large merchant, to attend at the same time lectures in Chemistry, Physics and Technology, and after completing his apprenticeship, to travel to France, Belgium and England, the lands of factories and industry, to keep his eyes open for this or that article, the making of which was urgently needed, and to become himself a factory owner.

That Messel's whole course of action was influenced by this letter it is clear, not only from the fact that he kept it to the last amongst his rarest treasures, but that he followed the advice it contained, almost verbally.

In April, 1863, he became apprenticed to E. Lucius, in his wholesale drug, chemical and pharmaceutical factory in Frankfort, where, according to a letter from Lucius, he obtained a thorough knowledge of the business in all its branches. He remained in Frankfort until September, 1866. Although there is no definite evidence that he attended lectures at the same time or who his teachers were, there can be little doubt that in this respect also he followed the advice given him. In 1864 and 1865 he was a member of the "Physikalischer Verein," which was then and later a teaching institution; the teacher in chemistry was Prof. Rudolph Boettger and in Physics first Prof. Oppel and later Prof. Friedrich Kohlrausch.

On leaving Lucius, Messel entered the Federal Polytechnic in Zürich, where he followed the regular first year course. Among the subjects taken were organic and inorganic chemistry (taught by Städeler); technical experimental physics (taught by Bolley); mechanics, mineralogy, botany and technical drawing. Messel completed his year in Zürich. The following winter he spent at Heidelberg studying organic chemistry under Erlenmeyer. According to a letter from Bunsen, he worked with the utmost zeal on analytical subjects in the laboratory of that great teacher, then in his prime. Bunsen, who wrote two years later, especially mentions Messel's manual dexterity, which he says, was

clearly shown in his later published researches on strychnine-oxyethylene compounds and sulphomaleic acid.

From Heidelberg, Messel moved in the spring of 1868 to Tübingen, where he finished his education. Here he spent a year attending the course of experimental physics of Prof. Reusch and courses in organic, inorganic and analytical chemistry by Prof. Strecker. From the spring of 1869 onward he appears to have been engaged in various inquiries under Strecker. A description of those referred to by Bunsen in the letter noted above formed the thesis he presented for his degree. Messel left Tübingen for England in April, 1870.

I believe he came to England originally to act as private assistant to Roscoe. During the short period he spent in Manchester, he worked both with Roscoe and Grace Calvert. The outbreak of the Franco-Prussian war, however, led to his recall to Germany. Owing to some physical defect, he did not serve in the army, but was relegated to the Ambulance Corps; he was wounded while on service. When recovered, he returned to England, where he remained during the rest of his life and ultimately became an Englishman. He entered the service of Dun, Squire and Co., at Stratford, as assistant to Dr. Squire, and here he became a thionist; but the virus was already in his veins.

In his Presidential Address, he tells of a conversation in the beginning of the 70's with his former teacher Strecker, of Tübingen—who was the first to discover the relationship of alizarin with anthracene—and Brüning, of Höchst, on the importance of fuming sulphuric acid in the synthetic alizarin industry, then rising into importance. To his question, how the acid should best be made, Strecker gave the prescient reply, "That is a problem for you to solve." A few experiments convinced him, he says, that given pure gases, the catalytic action of platinum was the rational solution of the problem. On April 8, 1875, a telegram came to him at the laboratory, from Squire, asking him to read up that night about Nordhausen acid, as it was wanted by an alizarin works. The response was Messelian and immediate: no reading was necessary. Next day he showed how simple a matter it was to marry sulphur dioxide with oxygen by means of platinum. However, Squire was conventional and thought that the decomposition of an acid sulphate would be a simpler method. Experiments were made as requested, but eventually Messel was told "to try his dodge."

With Messel to try what he had once conceived as practicable was to succeed. He was there already; he had seen and he conquered forthwith. A patent was taken out by Squire in 1875, and the process was described at the Chemical Society early in 1876. Meanwhile, Squire had established as a new firm Squire, Chapman and Co., with Messel as factotum; he would have objected to my calling him chemical-engineer, as he had no belief in half-breeds, also he was an entire disbeliever in the attempt to bring the works into the laboratory.

The process was established at Silvertown, and in 1878 he succeeded Squire as manager of the works, which he only quitted in 1915, when his health gave way under the excessive strain of the times.

The paper Messel and Squire read at the Chemical Society was never published: even I cannot say why; probably because of patents; from a remark made by Messel, I gather that it was not sent in by Squire. The record of the meeting on April 20 in the *Chemical News* runs simply as follows:—

> "The speaker (Messel), after giving a sketch of the history of the manufacture of sulphuric acid, described the process for preparing the anhydride. The vapour of ordinary sulphuric acid is passed through a white-hot platinum tube, whereby it is almost completely decomposed into water, oxygen and sulphurous anhydride: the mixed gases, after passing through a leaden worm to condense the greater portion of the water, are completely dehydrated in a leaden tower filled with coke, over which a stream of concentrated sulphuric acid is allowed to trickle. The dry mixture of oxygen and sulphurous anhydride is now passed through platinum tubes heated to low redness and containing fragments of platinum pumice, when the gases recombine to form sulphuric anhydride which is condensed in a series of Woulffe's bottles."

In early days, I was a frequent visitor at Silvertown, where Messel not only worked but also lived in the modest quarters of a small house attached to the works, until he removed to chambers in Ebury Street, and afterwards to Victoria Street. Characteris-

tic of the man throughout his career was his unpretentious, simple mode of life. I only knew him to be vain in one connection —as President of this Society; but he was very proud of the F.R.S., and not a few of us were proud of him as a colleague. Generous and ever thoughtful of others, unselfish to a degree, he had little thought for himself and a hatred of all display; the artist came out, first in his extreme devotion to his own art—for chemistry, technical chemistry in particular, is an art—then in his love of the company of artists and other bohemians: he was a great admirer and friend of Gilbert—of Gilbert and Sullivan fame—and a constant frequenter of the Savage Club; may I add, as a judge of quality in champagne; in Weib and Gesang he had no estate, though he was musical. Living among them, he knew his workpeople and was in sympathy with them: hence his popularity and power.

One understood his success when one followed his work. A man of astounding vigour and full of feeling, he burnt the candle at both ends and all over its surface. That he lasted so long always surprised me. When about sixty he was overtaken by diabetes. He was everything—not only chemist, engineer and business man: he also took care to cultivate the social side of his life: he was the only manufacturer of my acquaintance who attended regularly at scientific gatherings and showed real interest in the proceedings. He was thorough in everything he did. Probably he did far too much himself, but he could not suffer fools gladly, though not often impatient outwardly and always considerate. He had no hobby outside his business and science. During many years, his one way of recuperating was a weekly visit to Brighton on Sundays. He went down by the early train, walked out to the Devil's Dyke, had lunch, and then returned to town, usually to spend the evening with friends. In those days he was a real walker, as I found when occasionally his joyful companion.

Those who knew him, especially in the early days, will remember his vigorous frame, his black hair and sparkling eyes, his smiling face, his hearty bass staccato laugh, his peculiar gutteral accent. If his portrait were to be painted, I think we should ask the artist to depict just that smile alone, following Tenniel's living presentation of the Cheshire Cat up in the tree by its grin. We can fancy him to-day, smiling at King Ruttan and his crowd and at me the executioner, chuckling at my use of the axe of criticism. He never mastered English properly, though he spoke it fluently. He was very fond of young people, many of whom rejoiced in his generosity. We who knew him all think of him as one of the most lovable men* we have met. His outlook on life was always cheerful and optimistic, but he was a close observer and critic; always broad, clear and careful in his judgments but deliberate in forming them. The example he set in leaving his fortune to science is a remarkable one and best proof of his considerate outlook. Honest and sincere himself, he hated insincerity and all meanness of spirit. He combined in his person all the best of German good qualities, fired and softened by Jewish imagination.

Nordhausen or Fuming Oil of Vitriol was the only kind of sulphuric acid known to the early chemists. Even in comparatively recent times, not more than a hundred years ago, the manufacture of Vitriolic acid, by burning sulphur, was so imperfect a process that the old method, troublesome and crude as it was, still held its ground.

The production of the anhydride, by decomposition of a sulphate, appears to have been known in very early times, indeed up to the year 1736 the only way of preparing sulphuric acid was to evolve vapours of the anhydride by destructive distillation of a sulphate and to pass these into water.

When Messel and Squire began their work, Baron Stark, in Bohemia, was sole maker of the fuming acid, the process he used being substantially that of Basil Valentine, born 1394. A particular kind of Pyrite was weathered (oxidised) by exposure to the air. The copperas (ferrous sulphate) so formed was dissolved out and the solution concentrated. The sulphate crystals which separated were usually sold; the mother liquor, containing much ferric sulphate, was then evaporated to dryness and the residue slightly roasted, so as to dry it. The vitriol-stone, as it was called, so produced, was broken up and charged into small bottle-shaped retorts arranged in a gallery furnace, in such a way that they could be heated to a high temperature. Instead of receiving the vapours in water, as in making sulphuric acid, they were condensed in oil of vitriol, a small vessel containing the acid being luted to each retort.

The distillation lasted about 36 hours, and as the quantity put into each retort was small, the product was also small. The consumption of fuel was great, and much labour was involved in charging and discharging the retorts, many of which were broken. The process required great skill on the part of the workers. All attempts to manufacture the acid in larger apparatus appear to have ended in failure.

At the outset, when the attempt was made to produce the anhydride by passing the vapour of burning sulphur mixed with air over heated pumice coated with spongy platinum, the chief difficulty met with was in condensing the anhydride. As Messel and Squire remark—the manner in which sulphuric anhydride will evade condensation from a gaseous mixture is something quite marvellous. When pure gases were used, the condensation was easily effected; *on this account, in the early days of the* industry, when the value of the fuming acid was much greater than that of oil of vitriol, a suitable mixture of sulphur dioxide with oxygen was obtained by decomposing the latter. In their experiments referred to in the paper, a small platinum still, about 4 inches in diameter was so arranged in a Hofmann Gas Furnace that it could conveniently be maintained very nearly at a white heat. Ordinary oil of vitriol was slowly fed into the still and kept strongly boiling; the vapour was almost completely decomposed, the condensed water containing but little acid. After the mixture of gases had been dried by means of sulphuric acid, it was passed over pumice stone prepared with platinum, enclosed in a large tube made of thick platinum foil, heated to a dull-red heat by the waste heat of the gas furnace. Little or no sulphur dioxide passed away when the heat was properly managed, the process was continuous and the condensation perfect. Nearly 70 parts of anhydride were obtained from 100 parts of white sulphuric acid, the theoretical amount being 80 or thereabout.

In the early days, the demand was limited by the requirements of the dyestuff industry, especially that of the madder colours. When the use of the fuming acid was introduced into the Cordite industry, in connection with the displacement nitration process, the demand became much greater. At the close of his industrial career, Messel was producing from 250 to 300 tons of Oleum per week, containing 20 per cent. of anhydride in admixture with sulphuric acid.

As experience was gained and the difficulty of condensing the anhydride was overcome, sulphur dioxide prepared by burning sulphur and ordinary air were used. In this case also exact proportions were at first adhered to. I remember Messel telling me that he was first led to use excess of air and therefore to abandon the use of special appliances for the supply of the gases in due proportion by having his attention called, by his workman-foreman, to the fact that the plant worked better when air was supplied in excess.

In early days, to reduce the cost of carriage, acid was sent abroad of 80 per cent. anhydride strength and diluted with "monohydrate." Where this was done I forget, but that this was his practice I know, as when I once asked him if he had any knowledge of the process of making sulphuric acid (H_2SO_4) by freezing it out from oil of vitriol, he told me that he had at one time so made it for the purpose stated above.

Over and over again he told me that he aimed at making vitriolic acid by his process as cheaply as by the chamber process, and I well remember the joy with which he told me that he had at last succeeded.

Messel's claim to distinction does not rest upon the discovery of a chemical process, but upon his initial success in building up from the foundation, unaided and almost alone, a novel industry of great importance *and in having solved a variety of* technical problems of extreme difficulty. His success was due not only to his great mechanical ability and clear understanding of the task before him, but particularly to his high moral standard and his absolute devotion to work.

"The strongest weapon one can see
In mortal hands is Constancy."

Doubtless, in later days, as we all do, he derived assistance from outside, but this was only when his primary work was accomplished and it became necessary largely to extend the plant. We have been accustomed to admire the systematic manner in which the German chemical works are conducted with the aid of a considerable staff of trained, disciplined workers: what always appealed to me was the fact that he, a German working under our English conditions, with scarcely any technical staff, was long far in advance of his countrymen. His success was due, in the

first place, to his thorough scientific training and to his scientific outlook but, to an exceptional degree, to his moral attitude towards his work. The lesson to be learnt from his life should be of no small value to us.—(**Journal of the Society of Chemical Industry*, August 15, 1922.)

A MAGNETIC PROOF AND A SELF-CHARGING ELECTROSCOPE.

*By Major C. E. S. Phillips, O.B.E.**

A Magnetic Pivot.

This device may take various forms, and is intended to provide a means of rapidly setting up a delicate pivot in the laboratory. In the first of two examples exhibited a steel knitting needle stood vertically with its lower end resting upon a plate of glass, while the upper end was supported (without touching) by a permanent magnet held in a clamp immediately above.

The magnet could be lowered till the needle was nearly lifted from the glass plate, and, since the upper end was free and the lower end only pressing upon its bearing point with an extremely small force, the friction of the system was reduced to a minimum. It was then shown that the needle was very free to rotate about its axis, and that when a short arm was attached radially to the centre of it, and the needle itself slightly inclined, a control was afforded by the fact of the arm always moving so as to place its mass centre as low as possible. Under these conditions, but with the needle held nearly vertically, a slight lateral movement of the baseplate gave rise to a large deflection of the radial arm—possibly a useful application as an optical lever.

The other exhibit was a small sewing needle standing vertically with its point resting lightly upon the surface of mercury, while its upper end was supported by a magnet as before. It was explained that a convenient form of the pivot is also obtained by placing the magnet above the needle below with its point held against the convex surface of the glass. In this way large masses of magnetic material can be supported for rotational experiments in concave surface of a watch glass and a which it is required to eliminate friction as far as possible. Many other forms of the device will suggest themselves.

A Self-Charging Electroscope.

This electroscope was originally designed and used in 1910-11 for radioactive measurements, but was then found to have a serious defect. In 1911 Prof. Zeleny described an instrument working upon something the same plan, but both this and an improved form suggested in 1915 by Prof. Horton are not free from this same defect—viz., the occasional adhesion of the gold leaf to the charged surface with which it periodically comes into contact. In the original form of this electroscope the leaf moved intermittently against a carbon point, which was kept charged to a constant potential of −200 volts, while the leaf stem was connected to an earthed ionisation-chamber, so that with, say, radium present the leaf was continually charging up, and then periodically discharging by touching the carbon point. The number of kicks of the leaf per minute was, of course, dependent upon the extent of the ionisation in the chamber. In the electroscope exhibited the occasional "adhesion" of the leaf is prevented by coating the object touched by the leaf with a layer of fine carbon (arc lamp) powder. The powdered electrode may in fact be approached so closely to the leaf (or fine carbon filament suspended from a gold leaf hinge) that an almost imperceptible movement results which continues regularly and without appreciable adhesion. It was also explained that the arrangement has been made to give a sharp sound audible in a telephone at the instant the leaf or fibre strikes against the powdered electrode, and that this result is being utilised in the design of a recording electroscope. It is expected that the device will prove useful for the measurement of X-ray intensity, &c., and enable electroscopic observations to be made at a safe distance from the source of radiation.—(**Proceedings of the Physical Society of London*, Vol. XXXIV., Part V., August, 1922.)

NOTES FROM FOREIGN SOURCES.

RECENT ATTEMPTS TO SEPARATE ISOTOPES.

Abridged from the Journal de Chimie Physique, XIX., 4, 336.

(*Continued from Page* 90.)

As has already been pointed out, the separation of isotopes by ordinary fractional distillation, based upon a difference of vapour tensions, seems to hold out very small chances of success. On the other hand it is possible to make use of the difference between the rates of vapourisation of the isotopes which depends as directly as the rates of diffusion upon the mobility and thus the mass of the molecules. Very simple considerations lead to the inference that the number of molecules which escapes in a given time from unit area of a liquid (or returns to it) is proportional to the square root of the molecular weight. If, then, evaporation is brought about in a sufficiently rarefied atmosphere, so as to augment the mean free path, and if the vapourised molecules are eliminated by rapid condensation before molecular hits can direct them again towards the liquid, the light constituent of the vapourised and condensed part should be increased in quantity. However, this method can give satisfactory results only if an accumulation of the heavy molecules or atoms at the surface of separation of the two phases is avoided. Diffusion in the liquid state must be rapid enough to destroy the denser superficial layer which tends to form as fractionation proceeds.

The method of which we have just explained the principle was discussed in 1920 by **Bronstead** and v. Hevesy, who used it in their principal attempts to fractionate mercury. The apparatus in which evaporation and condensation were carried out was a flask or tube with double walls, in which a vacuum could be made, and from which the residual fraction and the evaporated and condensed fraction could be removed separately after the operation. The surface of the metal was at a distance of from 1 to 2 cm. from the bottom of the inner vessel, cooled exteriorly by means of liquid air. Three such pieces of apparatus were used, of capacities 300, 40 and 8 cc. Evaporation was generally carried on at a temperature of from 40 to 60°, which corresponds to a vapour tension of the order of 0.01 mm. of mercury and to a mean free path greater than the distance between the liquid surface and the cooled wall. In these conditions nearly all the molecules which left the liquid phase ought to condense on the cold wall before colliding with another molecule. The conditions of separation were less favourable in some experiments carried out at 120° (vapour tension 0.7 mm. of mercury, mean free path 0.15 mm. only), but even in this case the method was not useless.

2,704 cc. of carefully purified mercury were used. In the first series of fractionations the distillates were rejected and the successive residues were evaporated. The operations were continued till the 18th residue, amounting to 0.2 cc., was reached. The density of each fraction was determined by using pycnometers of 5 and 1.3 cc. capacity for the first residues, and a pycnometer of very small capacity made by drawing out both ends of a capillary tube, for the last fractions, the volumes of which were only a few cubic millimetres. The filling and weighing was carried out in such a way that the results were accurate to 0.0001 per cent. Each time the purity of the metal was controlled by subjecting it to several fractional distillations, followed by a density determination. The density of the mercury increased regularly from 1,000,000 (arbitrary value adopted for the pure ordinary metal) to 1,000,230 (density of the 18th residue). Thus the increase of density was about 0.025 per cent. In a second series of experiments the first distillate was taken and an attempt was made to increase the proportion of light isotopes by putting again into the apparatus after each fractionation the evaporated and condensed part. The density was then altered in the opposite direction, the value 0.999740 being reached at the 14th distillate (of volume 0.2 cc.). The variation was thus again 0.025 per cent. The difference of density of the two extreme fractions, 0.05 per cent., corresponds to a difference of about 0.1 in the combining weight of the mercury. According to the authors, this result was due to the partial separation of the isotopes of atomic weight 199 and 204.

The same method, without any essential modification, was applied by **Bronstead** and v. Hevesy to the separation of the isotopes of chlorine. The substance employed was a litre of aqueous hydrochloric acid 6.8

normal. Evaporation was carried out *in vacuo* at a temperature of $-50°$. The water vapour and hydrochloric acid condensed as before on the inner bottom of the flask or tube containing liquid air. Fractionation was continued till the distillate and the residual part were reduced to 100 cc. The hydrochloric acid of these last two fractions was converted into sodium chloride, and the combining weight of the chlorine contained in these salts was compared by two methods: (i) by determining the densities of their saturated aqueous solutions (at 20°); (ii) by measuring the E.M.F. of a cell made by solutions of the two isotopic salts, diluted so as to contain the same weight of NaCl per unit volume. The first method gave as result a difference of 0.024, and the second a difference of 0.021 in the combining weights of the two specimens of chlorine, which corresponds to a difference of about 0.06 per cent.

Thus, of the three recently employed methods—centrifugation, fractional diffusion, and evaporation, the two last have led to the partial decomposition of mercury, neon and chlorine. Moreover, three new methods have been suggested, and probably it will not be long before they are tested.

One of these methods depends upon the phenomenon of thermic diffusion. If two communicating vessels, kept at different temperatures, are fitted with a gaseous mixture, it will be found that when a stationary state is reached the heavier molecules preponderate in the cooler and the lighter molecules in the warmer vessel. This special diffusion, mentioned in 1911 by D. Enskog in a purely theoretical article, was subsequently studied by S. Chapman and F. W. Dootson, who suggested it as a method of separation for isotopes. According to the calculations of these authors and the conclusive experiments which they carried out with mixtures of hydrogen and carbon monoxide or sulphur dioxide, separation by thermic diffusion would be even quicker and easier to effect than ordinary diffusion. In an article appearing in March, 1920, W. D. Harkins announced his intention of applying the method to hydrogen and chlorine.

Certain incomplete chemical reactions between a gaseous phase and a solid or liquid phase might also lend to a partial separation of isotopes. Thus, according to Brönsted and v. Hevesy, chlorine could be fractionated by passing the highly rarefied gas through a silver nozzle: the lighter molecules $(Cl_{35})_2$, moving more rapidly, would strike the walls of the nozzle more frequently than the molecules $(Cl\ )_2$, so that the ratio of $Cl_{35}:Cl$ would be greater in the silver chloride formed than in the initial gaseous phase. J. J. Thomson has suggested an analogous method of separation, based upon the absorption of gaseous HCl by an alkaline solution. According to his calculations, $\frac{179}{180}$ of the initial gaseous volume must be absorbed in order to raise by 0.5 per cent. the density of the hydrochloric acid which escaped absorption.

Finally, T. R. Merton and H. Hartley have suggested a method of fractionation of chlorine based upon a difference of the wave lengths absorbed by the isotopes of this gas. If we suppose, in agreement with Aston, that normal chlorine contains 9 molecules of $(Cl_{35})_2$ and 6 molecules of $Cl_{35}\ Cl$ to 1 molecule of $(Cl\ )_2$, a beam of white light which had passed through a layer of the gas would contain fewer wave lengths absorbed by the light molecules; if this filtered light was used to bring about the combination of chlorine and hydrogen by the photochemical method, molecules of HCl_{35} would be obtained chiefly, since the wave lengths which are active in a photochemical reaction are those which the reacting molecules absorb. Whatever may be the future of this ingenious method, it is interesting to note that even spectral properties, hitherto regarded as the least likely to reveal the complexity of an element, are regarded to-day as being possibly able, in certain cases, to be employed in the separation of isotopes.

[END.]

INSTITUTE OF CHEMISTRY.

THE PRESIDENT'S ADDRESS.

By A. Chaston Chapman, F.R.S., March 1st, 1922.

I desire, in the first place, to offer you my thanks for the honour which you conferred upon me a year ago in electing me your President. While I very fully appreciate that honour, I also am keenly conscious of the obligations which the position carries with it, and of the great responsibility involved in the occupancy of a chair

in which I have been preceded by so many very distinguished chemists. I can only repeat the assurance which I gave you on the day of my election, that the best that I have to give is at all times freely at the call of the Institute, and express the earnest hope that, during my period of office, the usefulness of the Institute in the service of the profession of chemistry may increase, and that the high traditions associated with tsis chair may not suffer any diminution in my hands.

Owing to a variety of causes—foremost among which must be placed the intensive educational effect of the great war—the importance of chemistry to the national well-being is daily becoming more widely and more clearly recognised, and with that recognition has come a great development of the work of our Institute. A glance at the Report of the Council will suffice to show how numerous and how varied have been the problems calling for consideration and solution, and with one or two of these I should like, with your permission, to deal very briefly.

Before doing so, however, it is my melancholy duty to refer to the death of a number of our colleagues who were bound to us by close personal, as well as by professional, ties. Our losses during the past year have, I regret to say, been exceptionally severe, and include the names of men who have been prominent exponents of our science and who have contributed very materially to its advancement. The list includes the names of 30 Fellows, of whom no less than ten had served on the Council, seven Associates, and one Student. Although Dr. Odling's name appears in the list, a very sympathetic reference to his death was made by Sir Herbert Jackson in his address last year, and I need now perhaps only remind you that Dr. Odling was one of the petitioners for our Charter, and that he was President when that Charter was granted.

The death of Sir Charles Cameron, at the ripe age of ninety-one, removes from our midst a notable figure in the domain of public-health science, and an attractive personality. Sir Charles was elected a Fellow of the Institute in the year following its foundation, was a past Vice-President, and one of the signatories to the petition for a Charter.

In the death of Professor Edmund James Mills we have to deplore the loss of a very distinguished chemist who was an original Fellow of the Institute, and who filled at various times the offices of Councillor, Vice-President and Examiner.

By the death of Dr. Wynter Blyth, a Past Member of Council, sanitary science, and the chemistry of food and drugs, both sustain a severe loss.

In Edward Bevan, a Past Vice-President and Censor of the Institute, and a Past President of the Society of Public Analysts, professional chemistry has lost a prominent practitioner, and the Institute an active and loyal supporter. Possessed in an unusual measure of personal qualities which endeared him to those with whom he came into contact, his death will be felt by many of us as a severe personal loss.

In mentioning the names of Blount, Cassal, Hughes and Le Sueur, all of whom rendered the Institute good service in various capacities, I have, as in the case o Bevan, the sad duty of recording the passing away of old personal friends as well as of colleagues, who at one time or another have filled a not inconsiderable space in my professional life. Many who may read this address will understand and share my sorrow.

John Spiller's death, at the age of 88, will also bring to many of us a deep sense of personal loss. A former Member of Council, a firm friend of the Institute, and, notwithstanding his advanced age, a regular attendant at our annual meetings, his death not only severs a link with the past, but leaves a gap which will not be easily filled.

Of those who have not held office, we keep in grateful memory the name of W. J. Chrystal, and I would also like to refer to Walter Macfarlane, to whose able teaching metallurgical chemistry owes so much, and to Isaac Scarf, whose memory will be dear to very many past pupils of the City of London School.

I would that I might refer more adequately to the services to our science rendered by many of those who have passed from our midst during the year, but this is unfortunately not possible within the limits necessarily assigned to a Presidential Address.

Notwithstanding our losses during the year, you will see from the figures given in the Report of the Council that our membership shows an increase of no less than 371, in addition to 81 registered Students. The organisation of our profession is thus being steadily effected by the incorporation within our ranks of those who are trained and examined in accordance with the provisions of our Regulations. As one who entered the Institute by the iron gate of examination—to employ a phrase used by Professor Percy Frankland, himself an examined President—I would like to express my conviction of the wisdom of the action of the Councils under our immediate Past Presidents—Sir James Dobbie and Sir Herbert Jackson—in connection with the modification of our Regulations. The policy underlying that action was one for which I had long been an advocate, and in the light of our experience, I am confident that we shall have no cause to regret the step we have taken. The loyalty and unselfishness of our older Members has been beyond praise, and they have now the satisfaction of seeing the Institute based upon a sure foundation, and its position, as the body truly representing professional chemistry in this country, acknowledged alike by chemists, by the general public, and by the Government. To the professors and teachers in the universities and colleges we confidently appeal, to encourage the enrolment of duly qualified honours graduates, and we feel assured that the local sections will use their utmost endeavours to bring into our ranks the qualified chemists in their respective districts. In this way we shall continue to grow in influence and power, and our profession will, as a consequence, continue to maintain that high position to which it is entitled, from whatever point of view regarded.

You will see from the second section of thte Report that the Institute, through its representatives, has taken part in the work of several public and quasi-public bodies, and has been called upon to assist the Government in various matters. Our thanks are accorded to our representatives for their services.

Our Honorary Treasurer has already dealt very fully with the financial position, and to him we owe our gratitude. That our finances are in a sound and satisfactory condition at a time when many similar professional bodies are suffering more or less severely as the result of industrial depression and monetary stringency, is due in no small measure to the foresight which Mr. Voelcker has shown, and to the skill and unceasing care which he has devoted to the duties of his office.

The Benevolent Fund is making progress, and I am sure that our Treasurer would wish me to support his appeal for subscriptions. We naturally welcome the larger donations from those who are able to afford them, but what I would like especially to emphasise is the importance of receiving some contribution, however small, from all our Fellows and Associates, so that a substantial income may be assured. The existence of a profession ought to mean something more than a community of interests and occupation, and we should regard it as a privilege as well as a duty to help those of our brethren who, through no fault of their own, are in temporary difficulties, or have, perhaps, fallen by the way.

Under the new arrangement, introduced by the Council in March last, two of our Committees, the General Purposes, and the Nominations, Examinations and Institutions, now consist of the whole Council. For these Committees it is essential that there should be good attendances, and this arrangement has been found to work very satisfactorily. Under it every Member of the Council is afforded the opportunity of considering matters of general policy which come before the first-named Committee, and of examining in detail the various applications which are submitted to the second. The Report fairly sumarises the work of the Council during the year, and I am sure that you would not wish me, nor should I desire to attempt, to supply a commentary on every section. There are, however, one or two of the more important matters with which it deals on which I would like to be allowed to make a few remarks. As you are aware, the Board of Education approached the Council in May last with the object of inviting the cooperation of the Institute in connection with a new scheme designed to encourage day and evening students in technical schools to follow properly graded and balanced grouped courses of instruction in chemistry and allied subjects. The main idea underlying the invitation was that schemes of training evolved by the various schools should be subect to the approval,

not only of the Board of Education, but also of the Institute, and that the local certificates hitherto awarded to successful students, and which often had little more than local value, should be replaced by national certificates issued by the Board and bearing the imprimatur of the Institute. Whilst it was obvious that any scheme intended to raise the level of general scientific, and especially of chemical, training in our technical schools could only have our warmest sympathy, it was also clear that the proposals needed the most careful consideration in order that any action we might take should not operate to the detriment of our own Fellows and Associates.

(*To be continued.*)

GENERAL NOTES.

THE DIE-MAKING INDUSTRY.

Professor Henry E. Armstrong, writing in the current *Manchester Guardian Commercial* on the position of dye-making in this country, has some pungent comments on what he describes as our lack of insight and imagination. "What we have first to do," he says, "is to overcome the conceit of the commercial mind—to disabuse it of the idea that it is competent to exercise undivided control. Before you can sell you must make; the maker is at least as worthy as the seller. We have a sufficiently good example in the co-operative work of the late Dr. Mond and Sir John Brunner, both of whom I knew intimately. Mond made what Brunner sold, but neither was of use without the other. The British Dyesuffs Corporation has never had a proper hub, never sound spokes to its wheel; little wonder that it has never constructed a real rim upon which it can run. Yet we know so well how this might be done. Speaking proof is before us in British Alizarin Company and Scottish Dyes, Ltd. The dyestuff industry is not merely concerned with the production of dyestuffs; it is creative of colour, and love of colour must be behind it. Perkin was greatly aided by Pullar, of Perth, and he was himself an artist in several fields. His would-be succesors seem to have had no love of colour, to have been just dull drones. Herein our English industry has been greatly lacking—it has neglected the dyeing side; and our dyers, too have been so spoon-fed by the German firms, they have so relied upon them for instruction and even for assistance in matching colours, [illegible] alone the difficulties dyeing presents. The Germans owe their great success in no small measure to the great attention they have paid to the application of the dyestuffs they have produced. Our position to-day is one of 'plenty brains, no money'; and as we persist in keeping the brains out of action there is little chance of our gaining money. We have no conception of ignorance; if we had, those who have presumed to take charge would from the outset have realised that they have not the necessary knowledge and experience."

RUST PREVENTION ASSOCIATION.

More than 30 firms have now intimated their intention of participating in the establishment of an Association of Manufacturers of Non-Corrodible Products. Those firms in doubt as to whether their work comes within the province of the new Association, will find useful the following definitions of such products:

(1) Articles or materials liable to rusting, corroding, or decaying influences; which, for economic or technical reasons, are constructed, or partly constructed, of vulnerable substances; and are rendered impervious by special processes.

(2) Corrosive or decaying agents rendere dimpotent by special processes.

(3) Plant and materials for carrying out special processes for the purposes indicated in (1) and (2) above.

(4) Plant and materials for the removal of existing corroded or decayed matter, or rust.

All established firms manufacturing any such products, or operating any processes as indicated, are invited to apply for tickets to attend the preliminary meeting, as well as firms engaged in the sale of such products.

Firms engaged in the following manufactures have already intimated their intention to be represented:—

Electrolytically-proofed metals, acid-resisting chemical plant, boiler-scaling apparatus, anti-fouling compositions, anti-corrosive paints, galvanised iron, stone preservatives, lacquers, Japans, nickel alloys, stainless steel, rust eliminators, rustless ironware, boiler compositions.

It is desirable to state that the Royal Society of Arts is not promoting the new Association, and that all correspondence should he addressed to Mr. W. R. Douglas Shaw personally, care of The Royal Society of Arts, 18, John Street, Adelphi, London, W.C.2.

New Patents.

This *list is specially compiled for Chemical News* by **Messrs.** Rayner & Co., Registered Patent **Agents**, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

20829—*Anderson, E.B.*—*Process for obtaining new* shades on acetyl silk and new dyestuffs for use therein. July 29.

20241—Boehringer Sohn, C. H.—Method of preparing acetylene for anesthetizing. July 24.

20831—British Dyestuffs Corporation, Ltd.—Process for manufacture of dichlor fluorane. July 29.

20623—Gield, S.—Treatment *of* sulphide ores and minerals. July 27.

20192—Guggenheim Bros.—Manufacture of sodium nitrate. July 24.

20684—Humphries, H. B. P.—Ammonia distillation. July 26.

Specifications Published This Week.

157281—Helbronner, A.—Method of and apparatus for the manufacture of sulphuric acid.

158512—Elektrochemische Werke Ges.—Method for the production of sulphonated condensation products.

161165—Goldsmidt, V. M.—Manufacture of magnesium chloride.

182886—Dehn, F. B.—Process for the manufacture of insoluble condensation products from phenol and formaldehyde.

182988—Brunskill, W. B.—Treatment for obviating the rusting or oxidation of iron or steel surfaces.

183044—British Dyestuffs Corporation, Ltd.—Process for the manufacture of phthalimide.

Abstract Published This Week.

Extracting Lead.—Patent No. 181239.—Messrs. Chemical and Metallurgical Corporation, Ltd., of 701, Salisbury House, London Wall, London, have obtained a Patent for an adaption of acid-brine process of extracting lead described in their prior patent Specification 127641. It is applied to the extraction of lead from leady mattes such as mattes containing lead, copper, and zinc. The pulverized matte is treated with a hot, strong solution of a chloride, to which has been added hydrochloric acid, sulphuric acid, or an alkali bisulphate.

Messrs. Rayner & Co. will obtain printed copies of the published specifications, and forward on post free for the official price of 1s. each.

City of Cardiff Education Committee.

THE TECHNICAL COLLEGE.
Principal: CHARLES COLES, B.Sc. (Lond.).
DEPARTMENT OF INDUSTRIAL CHEMISTRY.
Head of Department: H. W. WEBB, M.Sc., F.I.C., F.C.S.
SESSION 1922-23.
(Commencing on Tuesday, 3rd October, 1922).
JOINT COURSE
(with University College of South Wales and Monmouthshire).

A COMPLETE COURSE in CHEMISTRY and Associated Subjects is provided for those wishing to become industrial chemists. The Course includes:—

Chemistry, Physics, Mathematics, Chemical Engineering, Utilisation of Steam and Electric Power, Cost Accounting, together with a specialised practical training in a branch of industrial chemistry chosen from the following:—

(1) Fuel,
(2) General Iron and Steel Manufacture.
(3) Gas manufacture,
(4) Foundry work.
(5) Tin-plate manufacture.
(6) Refractories and Cement.
(7) Electro Chemistry.
(8) Brewing.
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Examinations which are also catered for by the Course include:—
B.Sc. (Lond.) Ext.
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A number of Part-Time Courses are also available to cover requirement of work's Chemist, and those of various public examinations.

For further particulars of Full-Time and Part-Time Courses, Entrance Examination, Scholarships, Fees, etc., apply to the Principal. Forms of application for admission to the Entrance Scholarship Examination, duly completed, must be received by the 18th September.

JOHN J. JACKSON,
Director of Education,
City Hall, Cardiff.

THE CHEMICAL NEWS,

VOL. CXXV., No. 3255

A STUDY OF THE GLOW OF PHOSPHORUS.—PERIODIC LUMINOSITY AND ACTION OF INHIBITING SUBSTANCES.

By Lord Rayleigh, F.R.S.

(Reprinted by permission from the Proceedings of the Royal Society, A. Vol. 99.)

1. Introduction.

Many experimenters who have used cold phosphorus for the absorption of oxygen from air must have noticed the appearance of flickering clouds of luminosity when the action is nearly complete. These occur in the gas space and obviously represent a delayed action between the slight oxygen residue and the vapour of phosphorus.* This action has been discussed by Joubert,† who recognised it as due to the propagation of combustion in an explosive mixture. He obtained it in a more striking form by the slow leakage of air into an exhausted vessel containing phosphorus: his conclusion was that below a certain pressure, too small to measure, phosphorus vapour and oxygen became richer in oxygen by the inflow of the latter, the point was reached when combustion became possible and an explosion was propagated.

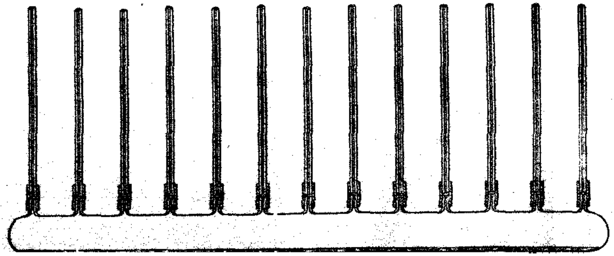
From the point of view of kinetic theory it seemed very strange that phosphorus vapour should behave thus. Joubert's view of the facts would seem to imply that the reaction of a molecule of phosphorus with oxygen was not dependant solely on the character and energy of molecular collisions, but also on the absolute value of the interval of time between them. These theoretical difficulties, and also the fascination of the experiments themselves, led me to attempt a further investigation.

2. Travelling Pulses of Luminosity. Need for the Presence of Water.

The earlier attempts were directed to getting the effect in as striking a form as possible. The first experiment which gave results worthy of record was as follows: A horizontal ylass tube 48 cm. long and 2 cm. diameter (fig. 1) was closed at the ends. Along the top side, at intervals of about 4 cm. a number of lateral openings were provided, to each of which was attached a long vertical capillary tube about 1 mm. in diameter, and 1 metre long. These tubes were open at the far end to the air of the room. Along the bottom of the main horizontal tube was a layer of phosphorus. This had been melted into position under a layer of water. After cooling, the water was poured off as far as possible. The lateral tubes were then attached as described. The phosphorus at first presented a uniform luminous surface where it glowed in contact with the contained air, but after a time when the oxygen began to approach exhaustion, a flickering appearance set in. This developed, as the action proceeded, into a very definite and distinctive form. At the side entrances air was diffusing into the nitrogen atmosphere, which contained phosphorus vapour. Luminous pulses were observed to spring into existence at

* *In this paper I do not enter upon the question of whether the glow is due directly to oxidation of phosphorus, or of phosphorus trioxide. When, for brevity, the oxidation of phosphorus is referred to, this reservation should be understood.*

† "*Ecole Norm. Annales,*" vol. 3, 1874, p. 209.



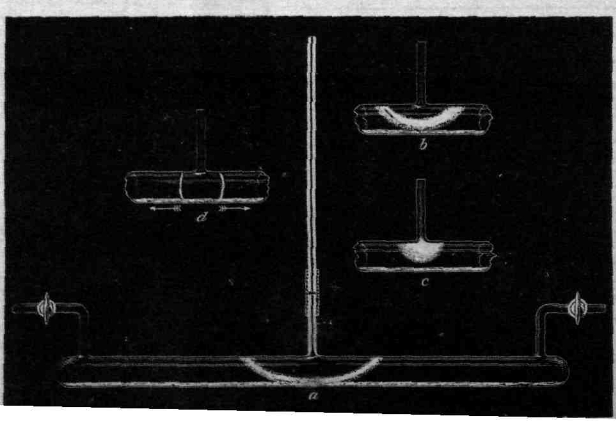
these side entrances, to divide, and to travel in opposite directions along the tube. The pulses were of the same diameter as the tube (2 cm.), and in thickness less than 1 cm. Their rate of travel was estimated at between 1 and 2 cm. per second. When two pulses originating at different places met one another, both were destroyed. It is easy to see why this should be the case. Suppose for distinctness of statement that the phosphorus vapour is in excess. Then each pulse as it passes leaves the space behind it exhausted of oxygen—its passage may be compared to the passage of an army living on the country, or a flight of locusts—no supplies are left in the rear. Another pulse meeting the first finds no oxygen to support its further advance or existence.

The arrangement of side entrances described was designed to provide, as far as possible, for a uniform admixture of phosphorus vapour and oxygen along the tube. On occasion a single pulse has been observed to traverse nearly the entire length. As a rule the pulses originated chiefly at two or three particular side junctions, perhaps owing to a favourable condition of the phosphorus surface for evaporation near these entrances; but the action was somewhat variable from day to day. A rise of the barometric pressure would cause oxygen to enter more rapidly than by diffusion, and a change of temperature also had some effect.

This apparatus continued to work well for a week or more, and was expected to do so almost indefinitely. But after a time it was noticed that the pulses were fewer and less brilliant, and that there were patches of stationary luminosity in the tube. After various possible explanations of the change had been examined, it was found to be due to the gradual drying of the phosphorus under the desiccating influence of the phosphorus pentoxide produced. On adding a few drops of water, the original condition was recovered.

For further examination of the effect of moisture, a tube was prepared, as in fig. 2, with a single side entrance, and a layer of phosphorus on the bottom. It was dried out by exhaustion on a mercury pump, with which a phosphorus pentoxide drying tube was connected. It was then filled up with commercial nitrogen (to save time), and the capillary entrance tube attached. There was now no trace whatever of the luminous travelling pulses. The glow, when air was entering, was perfectly steady, and took the form shown in fig. 2, *a*, *b*, *c*, which represent successive appearances as the air influx was gradually diminished. Any one of these stages could be maintained indefinitely.

On adding a few drops of water, a constant succession of travelling pulses was substituted for the steady luminosity (fig. 2, *d*). In this case a pulse, starting from where the oxygen was most concentrated,



divided, and travelled in each direction into a region where the oxygen became progressively scarcer. Thus the pulse gradually lost in intensity, and became extinguished after travelling a distance of perhaps 6 cm.

It is quite clear, then, that in these experiments the presence of water vapour is an essential condition for the periodic luminosity.

The quantity of water vapour necessary was next studied. In this case a tall, narrow exahusted bottle was used, near the bottom of which was hung up a small piece of phosphorus—a slice cut from one of the ordinary commercial sticks. Air could be slowly admitted through a capillary tube, so as to raise the pressure a few millimetres per hour (fig. 3).

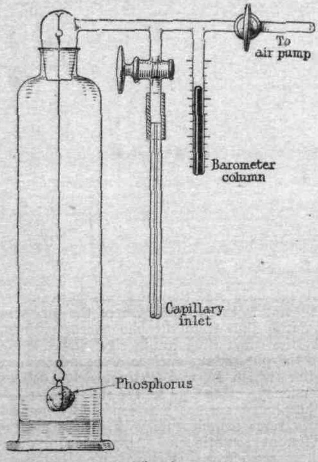


Fig. 3.

When the bottle contained a little water, intermittent luminous pulses travelled down it. Substituting strong sulphuric acid, the light at the top of the bottle, where air was diffusing into the phosphorus vapour, became quite steady. With acid of density 1.52 (vapour pressure 3 mm.), the flickering was much less conspicuous than with water only. Finally acid of density 1.66 (vapour pressure 0.8 mm.) was about the densest that would leave any perceptible unsteadiness in the light.

The saturation pressure of phosphorus vapour at ordinary temperatures is 0.025 mm. To get the intermittent luminosity will require a pressure of water vapour about 100 times as great.

It will be seen, then, that the quantity of water vapour required is of quite a different order of magnitude from that concerned in Baker's experiments.* He found that prolonged drying over phosphorus pentoxide would stop the action of oxygen on phosphorus altogether.

3. Experiments with Camphor.

The formation of luminous pulses evidently requires, as Joubert recognised, that combination between oxygen and phosphorus vapour should not occur until a certain concentration of oxygen is reached. At this point in the investigation it appeared clear that this restraining action was due to a peculiar action of water vapour. One could not fail to be reminded of the well-known action of ethylene, oil of turpentine, and numerous other substances, organic and inorganic, which are known to inhibit the oxidation and glow of phosphorus. Their action, it is true, is far more powerful than the action of water, but it seemed likely that the difference was only one of degree: if so, a judicious use of these substances would make it possible to get the travelling pulses in a much more striking form. This expectation was eventually confirmed. The earlier experiments made with ethylene and turpentine were not successful: I pass, therefore, to those made with the vapour of camphor:—

(1) A tubular bottle of 260 cc. capacity, about 15 cm. long and 4.5 cm. diameter, was used. At the bottom were placed a few pieces of phosphorus and a few pieces of camphor, about the size of peas.

No precaution was taken to keep the camphor and phosphorus separate, nor did this seem necessary.† The bottle was exhausted, and air allowed to leak in slowly through a capillary tube. The general arrangement was similar to that of fig. 3, though in the present case the phosphorus was not suspended. The air pressure rose at a rate of about 0.28 mm. per minute.

Five minutes after the evacuation, a brilliant pulse or flash of greenish yellow light was seen to pass down the bottle.

* "*Phil. Trans.*," 1888, *p.* 584.

† *Though an apparent charring of the camphor was noticed after some weeks.*

Another similar flash passed after $1\frac{1}{2}$ minutes, and after that succeeded a series of flashes. The interval between them soon settled down to a pretty regular value of about 1 minute.

If the experiment is allowed to continue with the same rate of admission of air, nitrogen accumulates in the vessel and makes diffusion less easy. At a pressure of a few centimetres it is found that the luminosity which passes down lingers on the surface of the phosphorus for a second or two, and then for longer. Finally the phosphorus remains continuously aglow, and the pulses cease.

It is possible, however, to work in an atmosphere of nitrogen at atmospheric pressure. In this case the admission of oxygen must be slower to allow for the much longer time needed for the diffusion of phosphorus vapour away from the phosphorus surface.

The same bottle, with the phosphorus and camphor undisturbed, was filled to atmospheric pressure with nitrogen, and a capillary tube, 45 cm. long and 1 mm. diameter, attached to the neck, so as to allow of slow diffusion of atmospheric air into the bottle. This showed most striking effects. Thin and very bright pulses would start up and travel slowly along the length of the bottle. Sometimes they started in the middle, dividing into two, one of which travelled up and the other down. At other times a pulse would start from the top or from the bottom, and traverse the entire distance in one direction. These pulses were from 1 to 2 mm. thick (diameter 45 mm.) and travelled about 2 cm. per second. They contrast with the pulses observed in a rarified atmosphere (1 cm. pressure), which were 10 to 20 mm. thick, and travelled at a speed roughly estimated at 1 metre per second. The latter were much brighter, as is to be expected from the much shorter time they take to traverse the vessel, for the amount of phosphorus burnt in each case is not very different.

The thinness of the pulses at atmospheric pressure is due, no doubt, to the diminished facility of diffusion. Sometimes they were very flat, and accurately perpendicular to the axis of the cylinder in which they moved. At other times they had irregular curvature and were oblique to the direction of propagation. These differences are doubtless to be attributed to irregularities of temperature in the vessel.

In the apparatus as described, the average interval between pulses was about 8 minutes, though its action was liable to temporary disturbance by changes in the barometric height. It has remained in good order for several weeks at the time of writing, and there is no apparent reason why it should not remain so for much longer.

Some other substances give very similar results to camphor. They were tried in the exhausted bottle only. A piece of filter-paper, moistened with the liquid, was placed at the bottom, and a piece of phosphorus hung just above (as in fig. 3). The substances found to behave thus were nitrobenzene, butyl alcohol, amyl nitrite, and oil of bitter almonds—one drop only of the latter on filter paper. No doubt the list might be much extended. Ammonia may be added to it (see 6).

4. Experiments with Pear Oil.

A piece of filter paper was moistened with pear oil (consisting chiefly of amyl acetate), and placed at the bottom of a narrow bottle (height 18 cm., diameter 6 c.), with a slice of phosphorus hung just above it. The bottle was exhausted, and air allowed slowly to leak in through a capillary tube. At first the phenomena were similar to those observed with camphor, but at a pressure of about 5 cm. a change occurred, the luminous pulse starting not from the top, where the air was entering, but from the phosphorus surface. At the same time luminosity would cling to the phosphorus surface a second or two, after which it was extinguished. This tendency of the pulse to start from the phosphorus surface was repeatedly noticed in various experiments with pear oil under different conditions. Amyl alcohol gives the same effect. It is possible that camphor, or some of the other substances, which have been classified with it, might do the same if the right conditions were found. But they certainly do it less readily, if at all.

5. Oil of Turpentine.

If a full quantity of this oil is placed in the bottle, luminosity is entirely stopped at all pressures up to the atmospheric. It was thought at first that a reduced quan-

tity would probably give the brilliant luminous pulses observed without camphor, but this did not prove to be the case. When only one drop was placed on filter paper, and introduced into the bottle, there was still enough vapour to inhibit the oxidation of phosphorus at low pressures.

The one drop may still have been enough to give saturated vapour. In order to reduce the effect, turpentine was dissolved in 100 times its volume of olive oil, or (in another experiment) in the same volume of medicinal paraffin. It was then found possible, with a very slow feed of air, to get periodic luminous waves, but they were of a different character from the comparatively thin and very bright pulses obtained with, *e.g.*, camphor. The head of the luminous wave was equally definite, but it left the whole track luminous behind it for a perceptible interval, after it had reached the bottom. All then became dark again.

These experiments seem to show that turpentine is not radically different in its inhibiting action from substances like camphor. The difference that there is cannot, however, be explained as merely due to a stronger action; for no concentration of turpentine, great or small, will give the effects as well as camphor.

The following oils, which were casually tried, seemed to behave like turpentine: aniseed, lavender, peppermint, eucalyptus, cinnamon.

(To be Continued.)

ALUMINA.

HYDROLYSIS OF ALUMINUM SALTS.

By Wilder D. Bancroft.

(*From the Journal of Physical Chemistry, June*, 1922.)

(*Continued from Page* 100.)

"Mr. Henry, justly sensible of the superior advantages of the acetated aluminous mordant in calico-printing, and conceiving it to have really been very anciently known and employed in those countries where the art was first practiced, concludes from thence, that it must have resulted from a very advanced state of chemical knowledge in those countries, at some very remote period, which was afterwards lost, whilst the improvements arising from it in this respect continued to be practiced and handed down, through a long succession of ages to the present time. To have invented (says he) the process of printing, in the manner described by Pliny, the inhabitants of India must probably have known how to prepare alum; they must have been acquainted with the manner of dissolving lead in the vegetable acids; they must at least have been acquainted with the component parts of these salts, and they must have had a knowledge of double elective attractions, etc. In truth, however, the inhabitants of India neither had, nor have they at present, any knowledge of the use of sugar of lead, or of any other preparation of that metal which could produce similar effects in calico-printing; a solution of common alum in water being their only aluminous mordant, and the previous application of the soluble parts of myrobalans and of buffaloes' milk, to their calicoes, aided by a very hot sunshine, and the complete desiccation which it produces, enabling them, without anything like an acetate of alumina, to give equal durability to their colours. This fact I have learned, not only from all the accounts published or transmitted to Europe respecting this point, but from the positive verbal informations of eye-witnesses to the practice of calico-printing in that part of the world, and particularly of a gentleman of great veracity, as well as knowledge on this subject, who formerly carried on the business of calico-printing very extensively in Bengal (principally for account of the East-India Company): and indeed sugar of lead is so far from being used for this purpose there, that within a few weeks I have received a letter from Mr. John Adie (successor to the gentleman last mentioned) dated, "Gondelpara, near Chandernagore, the 10th of February, 1792," and mentioning that he had some little time before been obliged to pay twenty shillings the pound for sugar of lead, in order to prepare a particular colour which I had formerly recommended; so far was this ingredient from being in use there for any such purpose.

"We may, therefore, safely conclude, that the formation of an acetate of alumina, and its application as a mordant in calico-printing, was not an oriental discovery; and that it did not result from any knowledge of double elective attractions, or any other extensive chemical knowledge,

either in ancient or modern times; since those who gradually stumbled upon and introduced the use of it were totally ignorant of the decompositions and recompositions which took place in their mixtures, and always supposed, as all other calico-printers have till lately done, and as most of them do now, that the aluminous mordant really consisted of everything used in producing it."

We know that textiles are often made *shower-proof* by coating the fibres with some water-repellent hydrocarbon, wax or salt,[1] the aluminum salts being often used. We also know that the probability of electrostatic charges is greater the dryer the material we are studying. Both these facts were known empirically to Napier.[2] "Pieces (of cloth) mordanted with acetate of alumina and dried at a great heat, are highly charged with electricity. If the hand be suddenly drawn along the piece, a complete shower of fire is observed, with a sharp cracking noise, at the same time a prickling sensation is felt. Whether this has any effect upon the mordant, in its immediately combining with other substances, we do not know, but cloth in this state is very difficult to moisten—water runs off it as off a duck's wing; but we offer no explanation."

Liechti and Suida[3] have made some experiments on the amount of alumina fixed by cotton from various solutions; but it is rather hard to tell from the abstract exactly what they did. "A weighed quantity of cotton was evenly impregnated with say, an alum mordant until its weight was exactly doubled, and then hung in a dry place on glass rods for thirty-six hours. A certain portion was then incinerated in order to determine the amount of alumina which the fibre had at its command. Another portion of the prepared fibre was then dried in a constant air current for six hours at a temperature of 40° C. The fibre was then washed for six hours with a definite amount of distilled water, and the amount of alumina in it was carefully estimated. From the number obtained it was possible to determine the percentage of alumina which had become fixed on the fibre." This sounds perfectly simple; but the catch is in the phrase "evenly impregnated." The cotton was apparently steeped in the bath and then dried with the mother liquor in it. Since all the solutions had the same amount of alumina in them, an amount equivalent to 200 g $Al_2(SO_4)_3.18\,H_2O$ per litre, one would have supposed that the amount of alumina presented to the fibre would be approximately the same in each case. Actually it varies in a ratio of more than four to one. The data are given in Table II. In the first column is the hypothetical formula of the aluminum salt in solution. In the second column is the amount of alumina in grams presented to the fibres, an absolutely mysterious item. There is nothing to show to what weight of cotton it refers. In the third column is given the amount of alumina in grams fixed by the cotton, and in the fourth the percentage fixed. The apparent accuracy is, of course, absolutely fictitious.

TABLE II.
Adsorption of Alumina by Cotton.

Formula.	Al_2O_3 presented to the fibre.	Al_2O_3 fixed by the fibre.	Percentage Al_2O_3 fixed.
$Al_2(SO_4)_3$	0.6971	0.0901	12.92
$Al_2(SO_4)_2(OH)_2$	0.4473	0.2283	51.04
$Al_4(SO_4)_3(OH)$	0.1527	0.0897	58.74
$Al_2(SO_4)(CH_3CO_2)_4$	0.5750	0.5190	90.26
$Al_2(SO_4)(CH_3CO_2)_3(OH)$	0.5012	0.5012	98.90
$Al_2(SO_4)(CH_3CO_2)_2(OH)_2$	0.1851	0.1851	91.19
$Al_2(SO_4)(CH_3CO_2)(OH)_3$	0.1987	0.1987	96.33
$Al_2(CH_3CO_2)$	0.2631	0.2631	51.27
$Al_2(CH_7CO_2)_4(OH)_2$	0.2213	0.2213	99.46

From these data it is not permissible to draw the conclusion, which Liechti and Suida draw, that with aluminum sulphate the percentage of alumina fixed is greater the more basic the mordant. The percent-

1 Weber: *Jour. Soc. Dyers and Colourists*, 17, 146 (1901).

2 "*A Manual of Dyeing*," 125 (1875).

3 *Jour. Soc. Chem. Ind.*, 2, 538 (1883).

age fixed varies with increasing basicity from 13 through 51 to 59; which is all that Liechti and Suida are considering. From what we know of adsorption, however, it is safe to say that the percentage adsorption would have been much greater than 51 if 0.15 g Al_2O_3 had been presented to the cotton instead of 0.45 g. The percentage adsorption for the hypothetical $Al_4(SO_4)_3(OH)$ would have been less than 58 if 0.45 g Al_2O_3 had been presented to the fibre instead of 0.15 g. It is quite possible, therefore, that under comparable conditions the percentage of alumina fixed by the fibre would have passed through a maximum with increasing basicity just as it appears to do with the so-called sulpho-acetates. On the other hand we do not know whether such a maximum, if found, would be real or would be due to the increased amount of sodium sulphate in the solution. In other words, although these experiments were made carefully, they are utterly worthless except as showing the errors which the next experimenter must avoid. Considering the time at which they were made, it is not surprising that the experiments are no better; but it is surprising that for nearly forty years they should have been considered as good work.

Kutschera and Utz[1] made some similar experiments, except that they hung the cloth, after drying, in the moist air at about 34° for forty-eight hours. They got a much more uniform mordanting of the cotton than Liechti and Suida did. One square decimetre of their cloth averaged seven grams in weight, and it seems probable, though not explicitly so stated, that this is the amount of cloth to which the figures in Table III. refer.

They confirm Liechti and Suida on the aluminum sulphate, and the basic aluminum sulphate. They are low (80 to 99) on the $Al_2(SO_4)(CH_3CO_2)_4$ and also (87 to 99) on $Al_2(SO_4)(CH_3CO_2)_3OH$. The great apparent difference is with aluminum acetate where Kutschera and Utz get all the alumina fixed, while Liechti and Suida get only 51 per cent. fixed. The difference may not be a real one because Leichti and Suida get more alumina fixed by weight than do Kutschera and Utz; but they present to the fibre 263 mg. as against 145 mg. It is quite possible that all the loss in efficiency comes in at the higher concentrations. This argument cannot be used to cover the cases of $Al_2(SO_4)(CH_3CO_2)_4$ and $Al_2(SO_4)(CH_3CO_2)_3(OH)$ because in both these experiments Liechti and Suida were getting higher percentages of alumina fixed with higher absolute amounts of alumina presented to the fibre.

Sodium aluminate is not used as a mordant in dyeing cotton; but it is padded on for calico printing.[1] There is no direct mordanting, and it is necessary to add ammonium chloride in order to precipitate the alumina. The use of aluminum formate [2] and of aluminum lactate[3] has been advocated. Whether one uses an acetate, formate, or lactate does not affect the general theory of the process.

Matthews,[4] who usually follows Ganswindt implicitly, breaks away from him on

TABLE III.

Adsorption of Alumina by Cotton.
100 cm of cotton averaged 7 grams.

Formula.	Al_2O_3 presented to the fibre.	Al_2O_3 fixed by the fibre.	Percentage Al_2O_3 fixed.
$Al_2(SO_4)_3$ $18H_2O$	0.1566	0.0186	11.88
$Al_2(SO_4)_2(CH_3CO_2)_2$	0.1456	0.1462	100.43
$Al_2(SO_4)(CH_3CO_2)_4$	0.1660	0.1324	79.76
$Al_2(CH_3CO_2)$	0.1446	0.1479	102.29
$Al_2(SO_4)_2(OH)_2$	0.1350	0.0688	51.79
$Al_2(SO_4)(CH_3CO_2)_3(OH)$	0.1495	0.1304	87.19

1 *Mitt. techn. Gewerbe-Museums in Wien, Sektion für Färberei*, 3, 110 (1886).

1 *Ganswindt*: "*Theorie und Praxis der modernen Färberei*," II., 224 (1903).
2 *Schwalbe*: *Zeit. Kolloidchemie*, 5, 129 (1907).
3 *Boehringer and Sons*: *Zeit. Farben-Ind.*, 9, 237, 253 (1910).
4 "*Application of Dyestuffs*," 602 (1920).

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the question of mordanting cotton, and comes out fairly boldly for the formation of a metallo-organic compound. "In mordanting cotton the case is somewhat different, for the metals employed as mordants are usually in the form of basic salts, and the solutions of these, by great dilution, by long exposure to the air, or by warming, may become dissociated and there may be precipitated either the hydroxide of the metal or a strongly basic salt; for example, in mordanting cotton with acetate of aluminum a hydrate or basic acetate is formed. This, however, cannot be considered as "precipitation" in the chemical sense of the term. Although it may be shown that when cotton is steeped in a readily dissociated solution of aluminum acetate, a portion of the aluminum is withdrawn from the bath, it cannot be shown, however, that aluminum hydrate as such has been precipitated in the fibre. If such were the case, washing with lukewarm acetic or hydrochloric acid would remove all the hydroxide from the fibre again; but this does not happen, which is an indication that the aluminum must be fixed in some other form. A properly mordanted fibre requires that the metallic compound with which the fibre is mordanted must be held by this in such a form and with sufficient energy that the mordant cannot be removed by water or even by dilute acids or alkalies."

After two paragraphs on the mordanting of wool with copper, aluminum, chromium and iron, Matthews concludes that "all these facts appear to show that in mordanting with metallic salts the metal is combined with the fibre in the form of a metallo-organic compound, and the fibre, thus chemically changed, then possesses the proper affinity for dyeing with the mordant dyes." The fallacy lies in the assumption that an adsorbed substance will necessarily have the same properties as the same substance in mass. If that were really the case charcoal could not take soluble substances out of solution practically completely, and yet we know it does. If cotton takes alumina out of aluminum acetate, there is no reason why dilute acetic acid should take any appreciable amount of alumina out of cotton and still less out of wool, which holds the alumina much more strongly.

(*To be Continued.*)

QUERCITOL AND ITS DERIVATIVES.

By John Missenden.

Quercitol was first discovered as an essential component of the acorn, which is the fruit of the two growths, *quercus racemosa* and *quercus sessiliflora*; by Braconnot, who, in his first writings upon the compound,[1] described it as lactose. Further investigation by Dessaignes[2] showed that it had a distinct chemical formula, $C_6H_7(OH)_5$, and he named it after the Latin root of its mother-growth, giving it the alternative appellation of "*sucre de glands*."

It is a crystalline substance of the monoclino-prismatic order, and is capable of rotating a ray of polarized light in a manner similar to the action of dextrose, thereby justifying Dessaignes' name of "acorn-sugar." The crystals are best prepared by treating an extract of acorn-juice with lead acetate, when the former will decompose. Certain colouring substances will be precipitated, together with tannin. The resulting filtrate should then be treated with yeast in order to rid it of such traces of glucose as may be present, and some other substance which will free it of lead. The remaining liquid should then be crystallised and recrystallised a number of times to rid it of impurities, hydrochloric acid being used as a solvent. The resultant crystals should have a fusion-point of between 224.6° and 225.2° C. Another method to produce quercitol is by the oxidation of quinone.

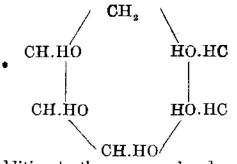
Application of heat at a temperature above 230° C. will bring about decomposition, quinhydrone, quinol, and other substances resulting; and treating quercitol with hydriodic acid under similar conditions produces, in addition to the two prementioned bodies, phenol, iodophenol, and benzene. Hexane may be formed by heating the volatile iodides also produced, by the reaction with five times the quantity of hydriodic acid.

Quercitol is soluble in water in direct proportion to its temperature, but is totally insoluble in both ether and alcohol; be-

1 *Ann. Chim. Phys.* (3), xxvii., 392.

2 *Compt. Rend.*, xxxiii., 308; 462.

sides which, it possesses a "sugary" taste. Its actual atomic constitution may be taken as follows:—



In addition to the sources already quoted Böttinger [3] also found it in the leaves and more fragile structures of the *chamærops humilis* (fan-palm), and in the rind and superstructures of the acorn. A less abundant quantity has also been produced from the stalks of the *quercus sessiliflora*.

Some derivatives of quercitol are:—

Nitroquercitol (or *pentanitroxy quercitol*), $C_6H_7(NO_3)_5$, which may be obtained by mixing together nitric and sulphuric acids in their concentrated states. It is soluble in alcohol, but completely insoluble in water, and takes the form of a gelatinous mass.

Pentacetoquercitol, $C_6H_7(C_2H_3O.O)_5$, which is a bitter substance, very soluble in alcohol, and slightly soluble in water, with an amorphous form. It is best prepared by heating together a mixture of acetic anhydride and quercitol.

Pentaquercylchloride, $C_6H_7Cl_5$, which is an example of the five molecules of hydroxye being replaced by five of another substance—an acid radical. In this instance quercitol has been heated with hydrochloric acid with the production of a chloride, but similar reactions may take place with other acids, forming a corresponding salt. Pentaquercylchloride is crystalline, and has a fusion-point of 103.5° C.

A considerable number of ethereal salts may be produced by heating together fatty acids (or their anhydrides) with quercitol, but they are so varied and of so little importance as not to merit especial mention.

3 *Liebig's Ann.*, ccii., 269.

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The Oilshale of Esthonia.

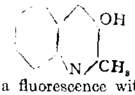
By E. H. Cunningham Craig, B.A., F.R.S.E., F.G.S.

Kukkersite is the name given to the oilshale of Esthonia, where it exists in a simple form, and with the exception of torbanites, is one of the richest. It varies from grey to green in colour, later turning reddish brown, and has S.G. 1.2 to 1.4. The mineral portion of the shale has the composition, silica 32.74 per cent. or less, alumina 15.76 per cent. or less, iron oxide 1.68 per cent. or less, lime or calcite 49.64 per cent. or less, which, disregarding the lime, represents a fuller's earth. The volatile matter varies from 54 to 56 per cent., and the total organic contents are composed of C. 70.52 to 72.82; H. 7.20 to 8.66 per cent.; N. 0.3 to 0.68 per cent.; O. 21.98 to 16.24; S. up to 1.60 per cent. Distillation of the oil from the shale can be completed at 500° C. or under. A yield of 70 to 80 gallons of oil (S.G. 0.93) can be reckoned upon. Dr. Perkin showed at the meeting of the Institute of Petroleum Technologists a sample of the oil from a three hundredweight test in a horizontal gas retort, distilling up to 480° C. The yield was 55 gallons per ton, the oil having the characteristics: S.G. 15° C. 0.9202; B.Th.U. 16825; Hash point 63° F.; S. 0.51 per cent. On fractionation 0.5 per cent. of water was found; up to 170° C. 25.5 per cent.; 170°-230° C. 15.0 per cent.; 230°-360° C. 40.0 per cent.; Residue (thick tarry oil) 19.0 per cent.—(*Jour. Inst. Pet. Tech.*, Vol. 8, p. 349.)

A NEW TEST FOR CARBOHYDRATES.

O. Bandisch and H. J. Denel.

The new test depends upon the formation of acetol, a ketone alcohol, when the simple carbohydrates are distilled with sodium bicarbonate. This compound is then detected by an appropriate test. The authors describe one test illustrating the method of using the method: 0.1 gm. of the sugar in 100 ccs. of water is treated with 5 gm. of sodium bicarbonate, is distilled to dryness, and the distillate collected. To this is added 30 mgms. of o-amino-benzaldehyde dissolved in a little alcohol, a small quantity of potassium hydrate solution and a piece of porous tile. The whole is evaporated to one-third its volume and acidified with HCl, and then made slightly alkaline with sodium bicarbonate. In the presence of a carbohydrate a bluish fluorescence will be seen, due to the condensation of the acetol with the o-amino-benzaldehyde to form 3-oxyquinal-

dine, 

and 8-oxyquinaldine gives a fluorescence with sodium bicarbonate. Positive tests have been obtained with arabinose, xylose, ribose, lyxose, glucose, maltose, and dextrin, but not with starch. As a rule 0.1 to 0.2 gm. of the carbohydrate in 100 ccs. can be detected.—(*Journ. Amer. Chem. Soc.*).

INSTITUTE OF CHEMISTRY.

The President's Address.

By A. Chaston Chapman, F.R.S., March 1st, 1922.

(*Continued from Page* 111.)

An Advisory Committee of the Institute was appointed to confer with representatives of the Board, and the matter was very thoroughly discussed in all its bearings. As an outcome of this discussion arrangements were entered into with the Board for approving schemes of training and for conducting examinations for the award of the "national" certificates, to which I have referred. Not the least pleasing feature in connection with this matter is the recognition accorded by the Government to the Institute as the body best qualified to advise in connection with chemical training, and the implied public confidence in the Institute's imprimatur. Your Advisory Committee were especially careful to ensure that steps should be taken to prevent any possibility of confusion arising between the new "certificates" and the diplomas of the Institute. The working of the scheme, which is to be put into immediate operation, will be watched with interest by us all. It should possess the great advantage of bringing the students at an early stage of their career into touch with the Institute, and so tend to diminish the number of those "hard cases" in which Students have discovered too late that their training has not been such as to render them eligible for our Membership. I would like to emphasise the point that nothing is farther from the intention of the Council than to lower in any way the standard of the requirements for the Associateship; for if there is one thing that must be clearer to us than another, it is that by the value of our diplomas we stand or fall.

I have intentionally given this question, bearing as it does upon the training of the chemist, an early and a prominent position among the matters to which I desire to refer. For so doing I need offer neither apology nor elaborate explanation. I submit that the training of the chemist—and by that I mean his general as well as his more technical education—is a matter of the deepest interest and importance to the Institute, to the profession which it represents, and to the nation at large. After all, a profession necessarily connotes that which is professed and the person who professes it, and in practice the two cannot be dissociated. I think I may say, without exaggeration, that the position of any profession in the public estimation is, in fact, even more dependent upon the general character of the men who follow it than upon its intrinsic importance. In any case the public are better able, as a rule, to udge of the former than of the latter.

In our own interest, therefore, and to take no higher platform, it is of the most vital importance that chemists as a body should possess educational qualifications, and, I would add, social qualities of no lower order than those which are associated with the members of the older professions, such as medicine or law. In an open and comparatively young profession, such as chemistry, it is obvious that not only should we endeavour to make clear to the public what we are, and in what our activities consist, but we ought to seek, by every means in our power, to ensure that we are represented by men possessing what we regard as adequate training and proper qualifications.

It may be asked how, in an open profession like our own, can this desirable end be attained? The answer is, that it is perhaps in the nature of an ideal; but just because our profession is an open one, it behoves us both in our corporate capacity, as Members of this Institute, and as individuals, to be especially careful so to bear ourselves that we shed lustre, or at least do not bring discredit on the profession of our choice. This brings me to a question which is ever present in our minds, and which has at various times occupied the attention of our Councils—I refer to the use of the designation "Chemist." I do

not believe that any single cause has contributed so greatly to the unsatisfactory position which professional chemistry has occupied in the past, in the esteem both of the Government and of the general public, as the misapplication—as we regard it—of the word "Chemist." In no other country—so far as I am aware—is there any confusion between the person who practises chemistry, and the person who follows the profession of pharmacy, and continental chemists have often expressed to me their inability to understand what they no doubt regarded as one of our many national peculiarities. The restriction of the title "Chemist" to the person who follows the profession of chemistry is obviously desirable, and no one would welcome such restriction more warmly than I. At the same time, we have to consider not only what is desirable, but what is practicable, and to those who may not fully appreciate the difficulties and complications with which this question abounds, I would recommend the careful study of the statement which has appeared in the last issue of the *Journal.*

This statement has been approved by the Council as a clear presentment of the case, and it is to be submitted to the local sections, with a request that they will consider it and transmit their views and suggestions, in due course, to the Council.

The arguments in favour of the restriction of the title, as well as those in favour of the restriction of practice and compulsory registration, may, I think, be found on close examination to be of a double-edged character, and we must move with the greatest caution in any endeavour we may make to amend the present admittedly unsatisfactory state of affairs. For the moment we must, I think, be content to express the hope that our friends, the pharmacists, without relinquishing their rights, will, whenever possible, refer to their ancient, important and very honourable calling by the word which more accurately defines and describes it.

I have discussed the matter at various times with a number of pharmacists, the majority of whom have expressed themselves as being quite willing to adopt the more correct style, and there are not a few who have discontinued the use of the word "Chemist" in referring to their occupation. The power—I might even say, the tyranny—of a word is often very great, and I would appeal to the Press, as a very important factor in the enlightenment of the general public, to assist, so far as they can—by employing the terms "chemist" and "pharmacist" respectively in their correct significations.

Only a few weeks ago, I noticed that the displayed contents bill of a prominent London evening paper, which was devoted entirely to a reference to a case of alleged poisoning, contained in large type the words: "Chemist's Evidence." I at first thought that the evidence in question was that of the Home Office Analyst, but on turning to the columns dealing with the case, I found that it was that of a pharmacist from whom certain purchases had been made.

It is bad enough when mental confusion is the unfortunate consequence of the poverty of a language, but in this instance the correct and distinctive words are ready to our hand, and the confusion is entirely of our own making, and readily avoidable.

I would like to echo the wise advice given by Sir Herbert Jackson in one of his Presidential addresses, that we should do well to adopt, in describin gourselves, the plain title "Chemist," and to omit as far as possible, such qualifying adjectives as "Consulting," "Analytical," "Research," or "Agricultural." This would not only indicate that we claim to possess that broad general training, without which specialisation is impossible or at least very dangerous, but it would also, I venture to think, be one very effective step towards making the public understand the proper meaning of the word.

Finally, it should be the business, I would even say the duty, of every properly qualified chemist to explain to all his friends and acquaintances the true nature of his calling, and to see that, so far as they, at least, are concerned, there is no room for misunderstanding.

I would even suggest that he should go further than this, and lose no opportunity of explaining and emphasising the great importance to the community of the profession of which he is a member.

The Institute of Chemistry and the various Chemical Societies are, in their corporat ecapacities, doing a great deal in this direction, but what is even more necessary is that every chemist should take a keen prid in his profession, and, realising his individual importance to the State, should constitute himself an active propagandist.

We are frequently told, and with a great deal of truth, that one reason why the profession of chemistry has not received that full degree of recognition to which it is entitled, is that the general public have only had a very vague conception of the nature of the chemist's activities.

We must not forget that, in this respect, chemistry is at a great disadvantage, as compared with medicine and the law, and I am convinced that proper and dignified methods directed to the education of the public would be productive of much good.

As I stated at the commencement of this address, the war proved a very powerful factor in that process of education, and the profession of chemistry occupies to-day in the public esteem a position such as I never thought possible in my life-time. At the same time, I cannot ignore certain indications that we are rather losing than gaining ground, and it behoves every one of us to help to the best of his ability to consolidate the position we have won, and to keep alive in the public mind the enormous national importance of the profession which we represent.

Whether we regard chemistry as a subject of study, essential to an understanding of the world in which we live, as an agent which has done so much to transform the life of man, as one of the most powerful factors in the creation of material wealth, or, finally, as that department of natural knowledge on which our national prosperity and our national security so largely depend, its supreme importance is equally manifest, and that importance it should be our business to make the public understand, and, having made them understand, to see to it that they are not allowed to forget.

To the young chemist, who is just on the threshold of his career, and who may think that what I have said chiefly concerns the older members of our profession and those who have made a position, I would say that he, also, is a representative of the profession, and, in that capacity, one of the guardians of its welfare.

I know something of the difficulties of our younger Members and of their hardships and disappointments, and I would like, with that knoyledge and much sympathy, to point out to them that, no matter how humble the tasks entrusted to them, they should remember that it is the worker who confers dignity upon the work, and bear themselves in such a manner as to compel respect, both for themselves and for the profession to which they belong. Everything must have a beginning, and if the profession which they have chosen is an exacting one, it has many compensations; perseverance and good and honest work will almost invariably bring their due reward.

It is a source of keen pleasure to me that it should have fallen to my lot to present the first medal with which the name of the Institute is directly associated. I refer, of course, to the Meldola medal, awarded for original chemical investigation of exceptional merit, and in memory of our Past President, Raphael Meldola.

This medal is the gift of the Maccabæans, a Society of which Meldola was also President, and which is associated with our Council in all matters relating to the award.

Many appreciations of Meldola's great services to Chemistry, and, indeed, to science in general, have been written, and it would, I feel, be out of place if I were to say more than that we remember with gratitude the good work he did for the Institute, and that we mourn in him the loss of a true friend and a very wise counsellor.

The Institute is fortunate in possessing the excellent portrait by Mr. Solomon J. Solomon, presented in 1917 by a number of Meldola's friends, and we welcome the further means now afforded us of honouring and perpetuating his meory.

In some respects, the award is, I believe, unique, for whilst it may be made for original investigation carried out in any branch of chemistry, it is intended primarily as a recognition of work of outstanding merit in the domain of Analytical Chemistry, a branch of our science which has not, I think, received in the past that degree of recognition which is its due.

The first recipient has, however, earned distinction by his work in Organic Chemistry, and I think it is perhaps due to him, in the circumstances above referred to, that I should say that the Board of Examiners and the Council were unanimous in their decision.

The medal, moreover, differs from many awards of a similar character in that it is restricted to British Chemists under thirty years of age, and is therefore intended to be a recognition of exceptional promise rather than of complete fulfilment, and I feel no hesitation in expressing the belief

that it will serve as a stimulus to our younger chemists, and will be regarded by them as a mark of high distinction.

Before passing on to another subject, I would like to take the opportunity of expressing our thanks to Dr. Spielmann for the great assistance which he, as the representative of the Maccabæans on the Adjudicating Board, has rendered us.

A matter which I regard as of very high importance, and which has occupied the attention of the Special Purposes Committee, is the home-production of laboratory glassware, porcelain and fine chemicals.

Having regard to the various interests concerned, and to the fact that some of these do not always run quite parallel, it is not perhaps surprising that different opinions on this subject should have been expressed. The view taken by the Council of the Institute, and by many others who are desirous of seeing these industries firmly established in this country, is that it would be a mistake of the first magnitude to allow ourselves again to be placed in that position of dependence on foreign—and possibly enemy—nations in which we found ourselves at the outbreak of war in 1914.

CINCHONA PLANTATION IN INDIA.

The last war has emphasised in a most emphatic manner the importance of adequate prophylactic treatment of malaria and has once more brought into prominence the vexed question as to the best derivative to thoroughly treat this disease and prevent its relapses. To realise the importance of this question, it is only necessary to remember that the greatest loss of effective man power particularly, of Eastern front, was due to malaria. To come nearer home, the toll of malaria every year in India, especially in Bengal, is appalling. One has only to go round the villages and witness for himself the devastations caused by this terrible scourge. Of all the measures of prophylaxis which have been tried so far, it may be said that none have proved a real success. Side by side with the prophylactic measures, treatment of cases of malaria is of equal importance, and the modern experiences of the *cinchona* has proved that in quinine, we have the highest form of curative measure. Since the isolation of *quinine* from cinchona bark, it has been regarded as a specific for malaria to the exclusion of all other alkaloids, and even as long ago as 1866 a committee was appointed by the Government of India who, after careful deliberations, came to the conclusion that *cinchonine*, *cinchonidine* and *quinidine* possessed a marked curative effect. In spite of this, however, *quinine* is still considered to be the one specific for malaria. It was, however, through the effort of Sir David Prain and Sir Clements Markham that cultivation of *cinchona* in India was improved and expanded. We are now beginning to realise that besides quinine there are other alkaloids of cinchona which give an enhanced cure-rate if properly administered. The question therefore which confronts us at the present moment is how far *cinchona*, and as a matter of that, other alkaloids can be supplied from our own cultivation. About 13 kinds of *cinchona* are grown at the present moment in the Government plantations; of these *Cinchona swuccirubra* and *Cinchona Officinalis* grow well and yield about 4½ per cent. of *quinine* and about an equal percentage of *quinidine*. The Government *cinchona* plantations manufacture *cinchona febrifuge* which contains several alkaloids. Unfortunately, however, the *cinchona febrifuge* that is produced in this country cannot supply the demands of India, and in addition to this the Government alone imports on an average about 54 thousand pounds of *quinine* from the United Kingdom mainly into Bengal. In the year 1904-5, 68,648 lbs., and in 1906-7, 71,737 lbs. were imported by the Government mainly into Bengal. These figures are rather significant and seem to show that a successful industry might be organised to meet the demands that create these imports.

Cinchona febrifuge is hardly ever used by the local practitioners for the treatment of malaria. Firstly because it is not always available in the market, and we are informed that the Presidency Jail has of late stopped its supply for some time. The other reason for not using this is because of the common prejudice that it is of less value than quinine and that *cinchonism* is more common than with *quinine*. Since this is a mixture of several alkaloids of cinchona bark and as it also contains *quinine*

and *quinidine*, it seems that it should be of greater value in treatment of malaria than *quinine* itself. These untoward effects are chiefly due to the alkaloid *cinchonine*, which causes more gastro-intestinal symptoms than any other alkaloid. It is possible therefore by a more careful manufacture, *cinchonine* content may be reduced and thus lessen the untoward effects. *Cinchona febrifuge* is cheaper than *quinine* preparations, and there is no reason why *cinchona febrifuge* should not be used on a larger scale, provided there is ample supply to meet the demand, when we know that in this we are assured of better results than either *quinine* or *quinidine* used by themselves.

At present the supply of *quinine* for the whole world is being done by the Dutch Government from their plantations in Java. It must, however, be remembered that in Java both the climate and soil are peculiarly favourable to cultivation of cinchona with a high percentage of quinine. Java will therefore always hold its own against India unless cinchona plantation is done in this country on a larger scale and on a commercial basis. It is therefore necessary that some experts well acquainted with the conditions of the soil and climate of the country suitable for cinchona plantation on a large scale, and chemists possessing the requisite knowledge of extraction of different alkaloids from the bark, and those who have the best knowledge of the action of these alkaloids on the human system, should investigate the question jointly and formulate such measures as will enable the country to produce sufficient cinchona, not only for its own needs, but also make a profitable trade by exporting the bark to foreign countries. India's demand for quinine is great and increasing, and it is a pity that with all the resources available, India has to depend upon Java for the supply of such a vitally important drug as quinine. At present there are about 18 quinine factories in the world—5 in France, 3 in England, 2 in Germany, 1 in Holland, 4 in America, 2 in India, and 1 in Java; but the modern trade centres mainly in Amsterdam. The world's demands for the bark average from 14 to 18 million pounds, of which India contributes about five hundred thousand pounds.

It is therefore important that the Government should pay more attention to cinchona plantation than before. If some experts were sent to Java to study the condition of cinchona plantation and the manufacture of quinine, it would be a considerable help to the Government in facilitating further expansion of *cinchona* plantation in this country. The whole question requires to be thoroughly sifted, and we would urge upon the Government that a committee on the lines indicated above be appointed, with instructions to report as early as possible after going through the whole question as to the possibility of production of *cinchona* alkaloid not only for the needs of the country which means so much money saved, but also for its export to other countrie sof the world.—(*Indian Medical Record*, July, 1922.)

GENERAL NOTES.

THE LIGHT OF THE FIRE-FLY.

The *Journal of the Franklin Institute* for August gives details of an important investigation upon this subject. The matter has engaged the attention of many Physicists in England, and is of considerable interest; the paper in question is by Herbert E. Ives, Ph.D., and gives details of the spectroscopic and photometric properties of the phosphorescent light produced by fire-flies and glowworms. The radiation is found to be confined between the wave lengths λ 5000 and λ 6000, and the author ventures the assumption that the *total luminous efficiency* is in the neighbourhood of 90 per cent.

The research is an exceedingly valuable addition to our knowledge of this interesting luminosity, and emphasises the difference between our most efficient methods of illumination and that of the insect. The author concludes with a quotation from Professor Langley. "There seems to be no reason why we are forbidden to hope that we may yet discover a method of obtaining an enormously greater result than we now do from our present ordinary means for producing light."

The same publication contains a paper "On the effect of absorbed gas on the electrical conductivity of glass," by V. Bush and L. H. Connell,

and the results lead the authors to the conclusion that gases penetrate through the volume of both glass and quartz, and can be removed by vacuum treatment.

Langmuir found that the gases removed from glass by heating *in vacuo* consisted chiefly of water vapour. Recent researches carried out in connection with the technology of glass manufacture in England show that a certain amount of water enters into the composition of practically all glasses. The subject, bearing as it does upon the important dielectric properties of glass, is of very great value. We note with interest that the authors propose to continue the investigation.

FLOTATION OILS.

One of the most striking successes of the laboratories was the discovery of a substitute for pine oil, used in the oil flotation process of refining ore. This process is extensively used in Canada. As originally developed, the process could only be worked by the use of pine oil, a product of the pines of the Southern States. Owing to the enormous demand for pine oil which the discovery of this process created, the price rose to ten and fifteen times its original figure, and frequently for months at a time Canadian reduction plants were unable to get it at any price. In this extremity a number of Canadian mine owners appealed to the Minister of the Interior, and the Minister directed the laboratories to investigate the question. The investigators succeeded in making pine oil from Canadian red pine stumps, but at a cost too high to render its use commercially feasible. They went further, however, and after eight months' work succeeded in utilising a waste product of the wood distillation industry. This waste product, slightly refined, was found to do the work in the reduction plants just as well as the original article. In this investigation the Forest Products Laboratories had the co-operation of the Department of Mines, the experts of which tested in practical ore reduction the different oils produced, until a satisfactory one was obtained. Canadian mining companies expressed their great appreciation of the work of the investigators. There are already many achievements to the credit of the laboratories, and the volume of work is constantly increasing. — (*Natural Resources of Canada*, August, 1922.)

DEPOSITS OF SOAPSTONE IN NORTHERN ONTARIO.

Many Industrial Uses for the Easily-worked Material.

What promises to be an important and valuable source of soapstone has lately been investigated by Mr. H. S. Spence, of the Mines Branch, Department of Mines. The deposit occurs one mile west of Wabigoon, on the Canadian Pacific Railway near Dryden, Ontario, and is but 500 yards from the railway. There is very little overburden, and the outcrops indicate a large body of soapstone.

The stone may be termed soapstone, though, beyond being soft enough to cut readily with an ordinary saw, it bears little resemblance to what is usually classed as soapstone. It is a dark, greenish-grey rock, composed largely of talc, and is very similar in appearance and in composition to the so-called "alberene stone" of Virginia, which is extensively used for switchboard panels, laboratory equipment and laundry tubs, and for lining furnaces and digesters, etc.

The Wabigoon deposit is the most promising, from an economic standpoint, of any of the soapstone occurrences as yet found in Canada; there appears to be large tonnage available, the location is ideal for quarrying, and close proximity to the railway provides satisfactory transportation facilities.—(*Natural Resources of Canada*, August, 1922.)

ROYAL SCHOOL OF MINES FRECHEVILLE RESEARCH FELLOWSHIPS.

The Imperial College of Science and Technology, South Kensington, London, S.W.7, with which the Royal School of Mines is incorporated, is offering two Research Fellowships of £300 a year each, tenable for one year and possibly renewable for a second year, to aid in carrying out any investigation or research connected with Mining, Mining Geology, Metallurgy, or the Technology of Oil, which in the opinion of the Selection Committee is of sufficient use or promise.

Applicants, who may be Associates of the Royal School of Mines or others, and preferably men with some practical experience, should apply in writing to the Secretary of the College (from whom further particulars may be obtained) before 1st September, 1922, giving the nature of the

neck and the forelimbs bend down as if to seek something on the floor. Tilt the muzzle upward and the forelimbs straighten and the hind limbs crouch as if to look up at a shelf. Purely reflex mechanism provides most kinds of ordinary postures.

Mere reflex action provides these harmonies of posture. The nerve-centres evoke for this purpose in the required *muscles a mild, steady contraction*, with tension largely independent of the muscle length and little susceptible to fatigue. Nerve-fibres run from muscle to nerve-centre. By these each change in tension or length of the muscle is reported to the activating nerve-centre. They say, "Tension rising, you must slacken," or conversely. There also play a part organs whose stimulation changes with change of their relation to the line of gravity. Thus, a pair of tiny water-filled bags set one in each side of the skull. In each of these a *patch of cells endowed with a special nerve*. Attached to hairlets of these cells a tiny crystalline stone whose pressure acts as a stimulus through them to the nerve. The *nerve of each gravity-bag connects, through* chains of nerve-centres, with the muscles of all the limbs and of one side of the neck. In the ordinary erect posture of the head the stimulation by the two bags right and left is equal, because the two gravity-stones then lie symmetrically. The result, then, is a symmetrical muscular effect on the two sides of the body, namely, the normal erect posture. But the right and left bags are mirror pictures of each other. If the head incline to one side the resulting slip, microscopic though it be, of the two stones on their nerve-patches makes the stimulation unequal. And from that slip there results exactly the right unsymmetrical action of the muscles to give the unsymmetrical *pose of limbs and trunk and* neck. An additional one postures the head itself on the neck; a second pair of tiny gravity-bags, in which the stones hang rather than press. These, when any cause inclining the head has passed, bring the head back at once to the normal symmetry of the erect posture. And these same bags manage the posturing of the eyes. The eye contributes to our orientation in space; for instance, to perception of the vertical. And for this the eyeball, that is the retina, has to be postured normally. The pair of little gravity-bags in the skull, which act to restore the head posture, act also on the eyeball muscles. Whichever way the head turns, slopes, or is tilted, these adjust the eyeball's posture compensatingly, so that the retina still looks out upon its world from an approximately normal posture, retaining its old verticals and horizontals. As the head twists to the right the eyeball's visual axis untwists from the right. These reactions of head of head and eyes and body unconsciously take place when a bird *wheels or slants in flight or a pilot stalls or* banks his aeroplane. And all this work itself involuntarily as a pure mechanism, whose analysis we owe mainly to Prof. Magnus and Dr. de Kleijn, of Utrecht.

True, in such a glimpse of mechanism what we see mainly is how the machinery starts and what finally comes out of it; the intermediate elements of the process we know less of. Each insight into mechanism reveals more mechanism still to know. Thus, hardly was the animal's energy balance in its bearing upon food intake shown *comfortably to conform with thermodynamics* than came evidence of the so-called "vitamines." Unsuspected influence on nutrition by elements of diet taken in quantities so small as to make their mere calorie value quite negligible; thus, for the growing rat, to quote Professor Harden, a quantity of vitamin A of the order of $\frac{1}{500}$ milligram a day. Again, as regards sex determination, the valued discovery of a visible distinction between the nuclear threads of male and female brings the further complexity that in such cases sex extends throughout the whole body to every dividing cell. Again, the association of hereditary unit-factors, such as body colour or shape of wing, to visible details in the segmenting nucleus seemed to simplify by epitomising. But further insight tends to trace the inherited unit character not to the chromosome itself, but to balance of action between the chromosome group. As with the atom in this heroic age of physicists, the elementary unit assumed simple proves, under further analysis, to be itself *complex. Analysis opens a vista of further* analysis required. Knowledge of muscle contraction has, from the work of Fletcher and Hopkins on to Hill, Hartree, Meyerhof, and others, advanced recently more than in many decades heretofore. The engineer would find it difficult to make a motive machine out of white of egg, some dissolved salts, and thin membrane. Yet this practically is what Nature has done in muscle, and obtained a machine of high mechanical efficiency. Perhaps human ingenuity can

learn from it. One feature in the device is alternate development and removal of acidity. The cycle of contraction and relaxation lies traced to the production of lactic acid from glycogen and its neutralisation chiefly by alkaline proteins; and physically to an admirably direct transition from chemical to mechanical effect. What new steps of mechanism all this now opens! To arrive at one goal is to start for others.

But knowledge, while making for complexity, makes also for simplification. There seems promise of simplification as to the mechanism of reflex action. Reflex action with surprising nicety calls into play just the appropriate muscles, and adjusts them in time and in the suitable grading of their strength of pull. The moderating as well as the driving of muscles is involved. Also the muscles have to pass from the behest of one stimulus to that of another, even though the former stimulus still persist. For these gradings, coadjustments, restraints, and shifts various separate kinds of mechanism were assumed to exist in the nerve-centres, although of the nature of such mechanisms little could be said. Their processes were regarded as peculiar to the nerve-centres and different from anything that the simple fibres of nerve-trunks outside the centres can produce. We owe to Lucas and Adrian the demonstration that without any nerve-centre whatever an excised nerve-trunk with its muscle attached can be brought to yield, besides conduction of nerve impulses, the extinction or attenuation or augmentation of them. That is remarkable, because the impulse is not gradable by grading the strength of the stimulus. Any stimulus of strength sufficient to excite the nerve-fibre at all, excites in it an impulse which is the fullest which the nerve-fibre can at the time give. The energy of the impulse comes not from the stimulus, but from the fibre itself. Lucas and Adrian have shown it gradable in another way. Though the nerve impulse is a quite brief affair—it lasts about $\frac{1}{1000}$ second at any one point of the nerve—it leaves behind it in the nerve-fibre a short phase during which the fibre cannot develop a second impulse. Then follows rapid but gradual recovery of the strength of impulse obtainable from the fibre. That recovery may swing past normal to super-normal before final return to the old resting state. Hence, by appropriately timing the arrival of a second impulse after a first, that second impulse may be extinguished or reduced or increased or transmitted without alteration. This property of grading impulses promises a complete key to reflex action if taken along with one another. The nervous system, including its centres, consists of nothing but chains of cells and fibres. In these chains the junctions of the links appear to be points across which a large impulse can pass, though a weak one will fail. At these points the grading of impulses by the interference process just outlined can lead, therefore, to narrowing or widening of their further distribution, much as in a railway system the traffic can be blocked or forwarded, condensed or scattered. Thus the distribution and quantity of the muscular effect can be regulated and shifted not only from one muscle to another, but in one and the same muscle can be graded by adding to or subtracting from the number of fibres activated within that muscle. As pointed out by Prof. Alexander Forbes, it may be, therefore, that the nerve impulse is the one and only reaction throughout the whole nervous system, central and peripheral, trains of impulses simply interfering, colliding and over-running as they travel along the inter-connected branches of the conductive network. In this may lie the secret of the co-ordination of reflexes. The nerve-centre seems nothing more than a meeting-place of nerve-fibres, its properties but those of impulses in combination. Fuller knowledge of the mechanism of the nervous impulse, many of whose physical properties are now known, a reaction open to study in the simplest units of the nervous system, thus leads to a view of nervous function throughout that system much simpler than formerly obtained.

Yet for some aspects of nervous mechanism the nerve impulse offers little or no clue. The fibres of nerve-trunks are perhaps of all nerve-structures those that are best known. They constitute, for instance, the motor nerves of muscle and the sensory nerves of the skin. When they are broken the muscle or skin is paralysed. They establish their ties with muscle and skin during embryonic life. These ties they then maintain practically unaltered throughout the individual's existence, and show no further growth. If severed, say, by a wound, they die for their whole length between the point of severance and the muscle or skin they go to. And then at once the cut ends of the nerve-fibres start re-growing from the point of severance, al-

though for years they have given no sign of growth. The fibre, so to say, tries to grow out to reach to its old far-distant muscle. There are difficulties in its way. A multitude of non-nervous repair cells growing in the wound spin scar tissue across the new fibre's path. Between these alien cells the new nerve-fibre threads a tortuous way, avoiding and never joining any of them. This obstruction it may take many days to traverse. Then it reaches a region where the sheath-cells of the old dead nerve-fibres lie altered beyond ordinary recognition. But the growing fibre recognises them. Tunnelling through endless chains of them, it arrives finally, after weeks or months, at the wasted muscle-fibres which seem to have been its goal, for it connects with them at once. It pierces their covering membranes and re-forms with their substance junctions of characteristic pattern resembling the original that had died weeks or months before. Then its growth ceases, abruptly, as it began, and the wasted muscle recovers and the lost function is restored.

Can we trace the causes of this beneficent yet so unaccountable reaction? How is it that severance can start the nerve regrowing? How does the nerve-fibre find its lost muscle microscopically miles away? What is the mechanism that drives and guides it? Is it a chemotaxis like that of the antherozooid in the botanical experiment drawn towards the focus of the dissolved malic acid? If so, there must be a marvellously arranged play of intricate sequences of chemically attractive and repellent substances dissolved suitably point to point along the tissue. It has recently been reported that the nerve-fibre growing from a nerve-cell in a nutrient field of graded electrical potential grows strictly by the axis of the gradient. Some argue for the existence of such potential gradients in the growing organism. Certainly nerve regeneration seems a return to the original phase of growth, and pieces of adult tissue removed from the body to artificial nutrient media in the laboratory take on vigorous growth. Professor Champy describes how epithelium that in the body is not growing when thus removed starts growing. If freed from all fibrous tissue its cells not only germinate, but, as they do so, lose their adult specialisation. In nerve regeneration the nerve-sheath cells, and to some extent the muscle-cells which have lost their nerve-fibre, lose likewise their specialised form, and regain it only after touch with the nerve-cell has been re-established. So similarly epithelium and its connective tissue cultivated outside the body together both grow and both retain their specialisation. All seems to argue that the mutual touch between the several cells of the body is decisive of much in their individual shaping and destiny. The severance of a nerve-fibre is an instance of the dislocation of such a touch. It recalls well-known experiments on the segmenting egg. Destruction of one of the two halves produced by the first segmentation of the egg results in a whole embryo from the remaining half-egg. But if the two blastomeres, though ligated, be left side by side, each then produces a half-embryo. Each half-egg *can* yield a whole embryo, but is restrained by the presence of the twin cell to yielding but a half one. The nerve severance seems to break a mutual connection which restrained cell growth and maintained cell differentiation.

It may be said that the nerve-sheath cells degrade because absence of transmission of nerve impulses leaves their fibre functionless. But they do not degrade in the central nerve-piece, although impulses no longer pass along its afferent fibres. This mechanism of reconstruction seems strangely detached from any direct performance of function. The sprouting nerve-fibres of a motor nerve with impulses for muscular contraction can by misadventure take their way to denervated skin instead of muscle. They find the skin-cells whose nerve-fibres have been lost, and on these they bud out twigs, as true sensory fibres would do. Then, seemingly satisfied by so doing, they desist from further growth. The sense-cells, too, after this misunion, regain their normal features. But this joining of motor nerve-fibre with sense-cell is functionless, and must be so because the directions of functional conduction of the two are incompatible.

So similarly a regenerating skin-nerve led down to muscle makes its union with muscle instead of skin, though the union is a functional misfit, and cannot subserve function. Marvellous though nerve regeneration be, its mechanism seems blind. Its vehemence is just as great after amputation, when the parts lost can of course never be re-reached. Its blindness is sadly evident in the suffering caused by the useless nerve-sprouts entangled in the scar of a healing or healed limb-stump.

But there is a great difference between the growth of such regeneration and the growth impulse in pieces of tissue isolated from the body and grown in media outside. With pure cultures of these latter Professor Champy says the growth recalls in several features that of malignant tumours. Multiplication of cells unaccompanied by formation of a specialised adult tissue. A piece of kidney cultivated outside the body de-differentiates, to use his term, into a growing mass unorganised for renal function. But with connective-tissue cells added even breast-cancer epithelium will in cultivation grow in glandular form. New ground is being broken in the experimental control of tissue growth. The report of the Imperial Cancer Research Fund mentions that in cultivation outside the body malignant cells present a difficulty that normal cells do not. To the malignant cells the nutrient soil has to be more frequently renewed, because they seem rapidly to make the soil in which they grow poisonous to themselves, though not to normal cells. The following of all clues of difference between the mechanism of malignant growth and of normal is fraught with importance which may be practical as well as theoretical.

The regenerating nerve rebuilds to a plan that spells for future function. But throughout all its steps prior to the actual reaching the muscle or skin no actual performance of nerve-function can take place. What is constructed is functionally useless until the whole is complete. So similarly with much of the construction of the embryo in the womb for purposes of a different life after emergence from the womb; with the construction of the butterfly's wing within the chrysalis for future flight; of the lung for air-breathing after birth; of the reflex contraction in the fœtal child of the eyelids to protect the eye long before the two eyelids have been separated, let alone ere hurt or even light can reach it. The nervous system in its repair, as in its original growth, shows us a mechanism working through phases of non-functioning preparation in order to forestall and meet a future function. It is a mechanism against whose seeming prescience is to be set its fallibility and its limitations. The how of its working is at present chiefly traceable to us in the steps of its results rather than in comprehension of its intimate reactions; as to its mechanism, perhaps the point of chief import for us here is that those who are closest students of it still regard it as a mechanism. But if to know be to know the causes we must confess to want of knowledge of how its mechanism is contrived.

And if we knew the whole how of the production of the body from egg to adult, and if we admit that every item of its organic machinery runs on physical and chemical rules as completely as do inorganic systems, will the living animal present no other problematical aspect? The dog, our household friend—do we exhaust its aspects if in assessing its sum-total we omit its mind? A merely reflex pet would please little even the fondest of us. True, our acquaintance with other mind than our own can only be by inference. We may even hold that mind as object of study does not come under the rubric of Natural Science at all. But this Association has its Section of Psychology, and my theme of to-night was partly chosen at the instance of a late member of it, Dr. Rivers, the loss of whom we all deplore. As a biologist he viewed mind as a biological factor. The keeping of mind and body apart for certain analytic purposes must not allow us to forget their being set together when we assess as a whole even a single animal life.

Taking as manifestations of mind those ordinarily received as such, mind does not seem to attach to life, however complex, where there is no nervous system, nor even where that system, though present, is quite scantily developed. Mind becomes more recognisable the more developed the nerve-system. Hence the difficulty of the twilit emergence of mind from no mind, which is repeated even in the individual life history. In the nervous system there is what is termed localisation of function, relegation of different work to the system's different parts. This localisation shows mentality, in the usual acceptation of that term, not distributed broadcast throughout the nervous system, but restricted to certain portions of it. Thus, among vertebrates to the relatively newer parts of that forebrain. Its chief, perhaps its sole, seat is a comparatively modern nervous structure superposed on the non-metal and more ancient other nervous parts. The so-to-say mental portion of the system is placed so that its commerce with the body and the external world occurs only through the archaic non-mental rest of the system.

(To be Continued.)

A STUDY OF THE GLOW OF PHOSPHORUS.—PERIODIC LUMINOSITY AND ACTION OF INHIBITING SUBSTANCES.

By Lord Rayleigh, F.R.S.

(Reprinted by permission from the Proceedings of the Royal Society, A. Vol. 99.)

(Continued from Page 117).

6. Experiments With Ammonia.

Ammonia gives effects like camphor. Its solubility in water, and the convenient control obtained by diluting the solution, makes it suitable for tests of how the period is controlled by the strength of the inhibiting substance, when air is admitted at a definite rate. The vessel used was a cylindrical bottle, 18 cm. long, and 6 cm. diameter. A capillary tube admitted air so as to raise the pressure 7 mm. of mercury per hour. The same capillary remained in use throughout the experiments with ammonia. A slice of phosphorus was hung up about 1 cm. above the layer of liquid at the bottom of the bottle (fig. 3).

Observations were made on the time required after evacuation for the pulses to begin, and also on the period. The latter was rather irregular at first, and somewhat longer than the steady value given, which was attained after the first few flashes had passed. Some residual irregularity remained, however, even when this comparatively steady state had been reached.

Ammonia density.	Time before first flash. *minutes.*	Period. *minutes.*
[1.00*	1.1	0.038]
0.997	4.5	0.43
0.994	12.0	0.55
0.982	52.0	1.2
0.965	150.0	3.1
0.960	More than 240	4.1
0.955	Character of phenomena changed	

* Water only.

Both the period and the time taken for the pulses to begin increase with the strength of the ammonia, but the latter time increases much more rapidly.

The time-lag before beginning measures the oxygen required to be present (1 minute = 0.023 mm. oxygen pressure), and the period measures on the same scale the oxygen consumed at each flash; for the steady *régime* implies that the oxygen consumed at each flash is the amount which leaks in during one period.

It appears, then, that the fraction of the whole stock-in-trade, so to speak, of oxygen, which is consumed at one flash, diminishes when stronger ammonia is used, and the period becomes slower. With the weakest ammonia, about one-tenth of the whole amount present was consumed at each flash; with the strongest, less than one-sixtieth. It is not surprising, in the light of this, that the successive periods vary considerably in length. These periodic pulses, arising suddenly, travelling from one end of the vessel to the other, with completely dark intervals between them, are attributed to the combustion of the phosphorus vapour already present in the tube. Immediately after a pulse has passed, all the phosphorus vapour is consumed and a fresh quantity evaporates during the dark interval between the pulses.

Obviously, if this *régime* is to be followed, there is a limit to the period, under the condition of constant influx, as in the present experiments with ammonia. The period cannot be longer than the time required to admit enough oxygen to burn the whole of the saturated phosphorus vapour.

If we take the phosphorus molecule as P_4, oxidising to P_2O_5, it will combine with five times its volume, and hence with five times its partial pressure of oxygen. The careful measurements of Centnerszwer* give the vapour pressure of phosphorus vapour at 20° C. as 0.025 mm. This would require 0.125 mm. of oxygen for its complete combustion.

In the experiments with ammonia of longest period (4.1 minutes) the oxygen entering in a period is 4.1 × 0.023 mm. = 0.094 m.m. This is 0.75 of the amount required for complete combustion, and therefore it might be anticipated that the limiting period for simple pulses has practically been reached.

Experiment confirms this. When the *ammonia concentration is increased still* further it is found that the character of the *régime* changes entirely, though it still remains periodic. Thin pulses no longer travel down the vessel, and there are no

* '*Zeit. Physik. Chemie*,' vol. 85, p. 99 (1913).

longer completely dark intervals. The space round the phosphorus is filled with a diffuse luminosity, which increases periodically in brightness, but which is never reduced to zero and is not propagated through the vessel in a detached pulse right away from its place of origin. In this case the conditions which determine the period are altogether different. The quantity of phosphorus vapour burnt during a period is not limited by the saturation pressure, since the amount of evaporation while combustion is actually proceeding is no longer insensible.

7. Some Unclassified Observations.

In addition to the phenomena described above, some others have been noticed which have not been investigated in detail. Thus in the experiments with camphor, I have sometimes seen a faint glow in the vessel before the passage of the brilliant pulse and heralding the approaching catastrophe. Sometimes, too, a faint glow remained for a second or two after the passage of the pulse.

Placing iodine in the vessel, the phosphorus surface would under some conditions light up and become abruptly extinguished again in a curious manner. It was thought that in this case chemical combination between phosphorus and iodine introduced some complication.

8. Probable Mode of Action of Inhibiting Substances in Preventing the Oxidation of Phosphorus.

The power possessed by a trace of ethylene or turpentine or ammonia in hindering the glow of phosphorus has always seemed very strange and difficult to explain. It is sometimes said to be an example of "negative catalysis," but this phrase is not of much help.

Although no complete account can yet be given, the present experiments seem to show in what direction the explanation lies.

Consider a luminous wave travelling through a vessel containing phosphorus, air, and some inhibiting substance. When once this wave has been started, it is propagated through the vessel. This implies that combustion in any layer is started by contact with a previous layer which is already in the act of combustion. Now why does contact with the layer already in combustion produce this effect? In the case of a mixture of oxygen and hydrogen the reply would be that the high temperature developed by combustion heats the neighbouring layer and starts that into combustion also. In the present case such an explanation is scarcely tenable, for the rise of temperature to be expected is too small. Consider the propagation in the experiment of p. 116 when the vessel was filled with nitrogen at atmospheric pressure. Let us suppose that the phosphorus vapour was saturated and that the whole of it was burnt—the least favourable supposition for the argument. Taking the vapour pressure as 0.025 mm. (Centnerszwer, *loc. cit.*) and the molecule as P_4, a litre of nitrogen contains 0.181 mgrm. of phosphorus. The complete combustion of this quantity would give 1.07 calories, and this would only heat the containing atmosphere of nitrogen 3.6°. This, then, is the highest temperature which could be communicated to a neighbouring layer in which combustion had not yet begun. It may well be doubted whether so small a rise could determine the propagation of combustion: but there is evidence that propagation takes place under much less favourable conditions even than this.

We have supposed that in the experiments with camphor at atmospheric pressure, the full saturation quantity of phosphorus is being burnt. In the much less brilliant and more frequent pulses obtained in presence of water vapour, the quantity burnt must be much less—at a moderate estimate, *e.g.*, five times less. But we may go further still: for in some experiments (see p. 115) the pulses obtained in presence of water vapour, faint at the best, become much fainter still as they progress, and are reduced in intensity, perhaps five times further still, before they finally die out.

In this latter case, if we take the brightness as a measure of the rate of combustion, as it appears reasonable to do, we must suppose that perhaps not more than 0.04 of the saturated concentration of phosphorus vapour is being consumed. This would only give a rise of temperature of about 0.14° C., and it is still harder to believe that this would determine propagation.

If propagation is not due to rise of temperature, what is it due to? I think we must attribute it to the provision of nuclei.

There is a well known experiment on supersaturation which will illustrate what is meant. A supersaturated solution of,

e.g., sodium acetate, is contained in a long glass tube. If a fragment of the crystallised salt is dropped in at one end, crystallisation is propagated along the tube. The crystallisation of any given layer provides nuclei which determine the crystallisation of the next layer.

Similarly, I think we must suppose that the combustion of phosphorus provides nuclei which facilitate the action. The action postulated has some analogy with the action of platinum or other solid surfaces in promoting union of hydrogen and oxygen. The gaseous or particulate products of combustion of phosphorus are assumed to act somewhat similarly.

Coming now to the inhibiting substances, I think these must be supposed that these act by taking prior possession of the nuclei, and thus making them unavailable for propagation. That water, and still more, ammonia in presence of water, would seize on the products of oxidation of phosphorus, is no more than we may anticipate from the acid-forming character of the latter. In the case of camphor or turpentine, the kind of action here assumed has become familiar in studies of the mobility of gaseous ions in air at atmospheric pressure. The ions tend to unite with gaseous molecules, as evidenced by their diminished mobility in an electric field; and this effect is highly selective. A trace of water vapour or of an organic vapour has far more tendency to load the ions than a full atmosphere of nitrogen or hydrogen.*

The original spontaneous ignition is regarded as due to something which, from a molecular point of view, is a rare accident, concerning a few molecules only. Unless it can be spread and multiply, it effects practically nothing: being in this respect like a single microbe in the putrefaction of wounds. The presence of a small quantity of a vapour like oil of turpentine, by attaching itself to the product, prevents the latter from inducing the combination of the neighbouring phosphorus molecules. From this point of view, it is not specially surprising that a very small quantity of the inhibiting substance should in some cases be enough to stop the action. It is often quoted as a surprising fact that one part of ethylene in 400 parts of air inhibits the glow of phosphorus. But, after all, even at this dilution, the partial pressure of the ethylene is still about 100 times the saturation pressure of the phosphorus vapour itself. There can be little doubt that the glow of phosphorus is in all cases due to the oxidation of vapour, since the phenomenon may be traced continuously from atmospheric pressure to low pressures, and in the latter case occurs visibly at a distance from the phosphorus surface. At low pressures the vapour has a chance to diffuse away to some distance before getting oxidised.

Where, as in the periodic luminous pulses, an increasingly favourable composition of the phosphorus-oxygen mixture eventually starts a wave of combustion in spite of the inhibitor, we must suppose that the action of the inhibitor in destroying the nuclei is overwhelmed by the too rapid multiplication of the latter; just as the too rapid multiplication of invading bacteria in a wound may overwhelm the destructive action of the phagocytes and enable infection to spread.

The question may be asked why some of the inhibiting substances — like water, camphor, and ammonia — lend themselves so much more readily to the formation of intermittent luminous pulses than others, like turpentine and eucalyptus oil. As already shown, the latter class can be made to give the effect by dilution, but not so well.

Striking as the difference is, it is probably not very fundamental—not perhaps more fundamental than the condition of "hunting" or not hunting in a self-regulating mechanism, such as a steam engine governor or an automatic arc lamp.

In these cases a general explanation of the action of the mechanism is by no means sufficient to determine whether it will "hunt" or not. Nor can the provisional theory of the action of inhibiting substances which has been given be expected to do so.

9. Summary.

The paper deals with the intermittent or periodic luminosity observed to be propagated through the gas space when the last traces of oxygen are being removed from air by means of phosphorus, or when the air is allowed slowly to leak into an exhausted vessel containing phosphorus.

* *To avoid misconception it is well to state specifically that I do not assume that the ions produced in the oxidation of phosphorus have necessarily anything to do with the matter.*

(1) It is shown that this effect, as ordinarily observed, requires the presence of water vapour. Moderate drying (*e.g.*, by sulphuric acid) makes the glow perfectly steady. Water vapour has therefore the power of inhibiting the combination of phosphorus vapour and oxygen within certain limits. When the composition of the mixture becomes favourable beyond those limits, a wave of combustion is propagated.

(2) Other substances are known to inhibit the glow of phosphorus. Some of these can be used to exhibit the above phenomena in a far more striking form than water. Camphor, ammonia, and pear oil are among the most effective, and experiments with them are described in detail.

(3) It is shown that the propagation of these waves of combustion cannot be attributed to the rise of temperature of one layer igniting the next layer, for the rise of temperature is too small. An alternative theory of the propagation is proposed which assumes that it depends on the provision of nuclei, as in the propagation of crystallisation through a super-cooled liquid.

(4) On this basis a theory of the action of the inhibitors (sometimes called "negative catalysts") is developed.

[END.]

ALUMINA.

HYDROLYSIS OF ALUMINUM SALTS.

By Wilder D. Bancroft.

(*From the Journal of Physical Chemistry, June,* 1922.)

(*Continued from Page* 120).

Ganswindt [1] believes in distinguishing sharply between the mordanting of wool and of cotton. "The mordanting of cotton is quite different from the mordanting of wool and silk; it has also quite a different intention and significance. The cause of the difference is the inactivity or indifference of cotton towards solutions of salts of the metals. While silk and wool take up the metals in any form on heating, often quantitatively, and fix them chemically, that is not the case with cotton. Cotton has no affinity for metal salts and no tendency to form metallo-organic compounds; even boiling for hours has no effect. It is therefore necessary to have recourse to solutions of strongly basic salts, solutions which are so labile that a mere diluting with water, gentle heating, or just the presence of a textile fibre will cause the solution to dissociate into a normal solution and into a precipitate, which latter, at the moment of precipitation, is taken up on or in the fibre. It is not necessary to decide whether the hydroxide is taken up or a more basic salt than that in the original solution, for that point has no bearing on what is to follow. It is a fact, however, that no chemical compound is formed, and that the cotton fibre is not changed chemically in any way by the mordanting or, more properly speaking, by the steeping in the salt solution. Strictly speaking the cotton is not mordanted at all. When cotton is mordanted, the phenomenon is different from that with wool and silk, in that actually the metal hydroxide or possibly a very strongly basic salt is precipitated mechanically on the cotton fibre and can be removed to some extent by vigorous rinsing. The hydroxide that is left is also held mechanically, but in the intercellular spaces.

"The mordanting with tannin and tartar emetic must also be considered as a mechanical process, for there is only a very slight affinity between tannin and cellulose. If one mordants cotton with tannin, it is possible to wash the tannin out quantitatively by repeated treatments with hot water. That is why it is necessary to fix tannin with tartar emetic. Cotton mordanted with tannin and tartar emetic is nothing more than cotton impregnated mechanically with antimony tannate. It is exactly similar when cotton is mordanted with Turkey red oil and aluminum acetate. In all cases the cotton itself remains entirely unchanged. It is not altered or affected chemically in any way and therefore one really ought not to call the process mordanting at all. The only case where there is actually a chemical change in cotton by the action of reagents is curiously enough not called mordanting but —mercerisation.

"From all this it is clear that the mordanting of cotton is not at all the same thing as the mordanting of wool. The

[1] "Theorie and Praxis der modernen Färberei, II., 214 (1903).

mordanting of wool is pre-eminently a chemical process, while the mordanting of cotton is a mechanical impregnation of insoluble metallic compounds in the cell spaces and pores of the cotton fibre. For this reason the mordanting of cotton with metallic salts is nothing like as important or interesting as the mordanting of wool. The organic mordants, tannin and oil, are much more important."

This is quite an unreasonable attitude to take. The difference between wool and cotton is purely one of degree, so far as we now know. Wool adsorbs alumina more strongly than cotton does, and is therefore able to take up alumina from less basic solutions than cotton. Since it adsorbs alumina more strongly than cotton does, it also holds it more firmly, thus makes a fixing of the mordant unnecessary. That point will be discussed in detail in a later paper. There is no satisfactory experimental evidence as yet of the formation of any definite chemical compound between alumina and either wool or cotton. Specific adsorption will account satisfactorily for all the phenomena which have been observed as yet.

It is interesting to note that the one case where Ganswindt is willing to admit a chemical change and a consequent mordanting is that of mercerised cotton; and Leighton has since shown that all the earlier work on the theory of the process was wrong, and that there is no definite chemical compound formed when cotton is mercerised. It is true, of course, that mercerised cotton does adsorb basic and substantive dyes more strongly than ordinary cotton does, and it is apparently true that mercerised cotton takes up basic mordants rather more completely from concentrated solutions than ordinary cotton does; but there is no reason to suppose that this is anything more than an increased adsorption due to a change in structure.

The general results of this paper are:

1. All aluminum salts hydrolyze more or less in aqueous solution and the amount of the hydrolysis increases with rising temperature.

1 *Jour. Phys. Chem.*, 20, 188 (1916).
2 *Matthews: "Application of Dyestuffs,"* 165, 278 (1920).
3 *Schaposchnikoff and Minajeff: Zeit. Farben-Ind.*, 3, 165 (1904); 4, 81 (1905).

2. The actual hydrolysis is greater with weaker acids; but the apparent hydrolysis may be abnormally large in sulphate solutions owing to the coagulating effect of the sulphate ions on the colloidal alumina.

3. The different fibres adsorb alumina to different degrees, wool having a much greater adsorbing power than cotton, and silk being probably slightly inferior to wool.

4. Owing to this difference in specific adsorption, wool decomposes aluminum salt solutions which are distinctly acid, while cotton is effective only in more basic solutions.

5. What is taken up and held firmly is the colloidal alumina. While coagulated alumina may be adsorbed to some extent, it rubs off easily.

6. It is probable that in all cases alumina is adsorbed and not a basic salt. The phenomena may be complicated by the fact that the alumina itself will adsorb some sulphuric acid, for instance, and that the wool may, and probably does, adsorb some sulphuric acid also.

7. Since alumina is adsorbed less strongly by cotton than by wool, it is also held less strongly by cotton than by wool.

8. If we add to cotton some substance like tannin which adsorbs alumina strongly, the cotton mordanted with tannin will be able to take alumina out of aluminum salt solutions which are not decomposed by cotton alone. A corollary from this is that alumina will be held more strongly by cotton mordanted with tannin than by cotton alone.

9. The increase in adsorbing power shown by mercerised cotton is undoubtedly due to structural difference in the cotton fibre; but we are not yet able to predict this change.

10. There is no evidence of the formation of any definite chemical compound between alumina and either wool, silk, or cotton.

Cornell University.

[END.]

INSTITUTE OF CHEMISTRY.

THE PRESIDENT'S ADDRESS.

By A. Chaston Chapman, F.R.S., March 1st, 1922.

(Continued from Page 125.)

The whole chemical industry—and I include, of course, all those industries which are essential to the successful conduct of war—the prosecution of scientific research, with all that that implies, and the practical

teaching of science in our schools and universities, all depend upon a supply of laboratory glassware, porcelain and chemicals, adequate in quantity, suitable in quality, and, I would add, reasonable in price.

With the political aspect of this matter I have, as President of the Institute, no concern, but on national grounds it is obviously desirable that this country should be ever directing its activities to production and to the increasing development of its internal resources, with the consequent creation of new wealth, rather than to distribution.

There is, moreover, the further consideration—and it is one which is very much in the mind of the Council—that the establishment in this country of these essentially chemical industries would lead to increasing demand for the services of properly qualified chemists.

I am prepared to admit that there may be certain appliances and certain chemicals which, for sufficiently good reasons, can be better manufactured by firms in other countries, with whom it might be very difficult, or even impossible, for us to compete successfully, and I have no hesitation in expressing the view that if our own manufacturers cannot supply apparatus and chemicals of the necessary high quality and at a suitable preie, these must be obtainable elsewhere, without let or hindrance.

I do not think, however, that British manufacturers should feel that they can count not only on such encouragement as the Government can give them, but also upon a very full measure of the support and sympathy of those in whose interests, and at whose instance, the industries in question were established.

From the purely commercial point of view, the manufacture of highly specialised apparatus and of very pure chemicals, both of which are needed in comparatively small quantities, cannot be particularly attractive. Unless, therefore, British firms do receive such support as I have referred to, these newly born industries must languish and ultimately disappear.

If there were evidence that British manufacturers are not prepared to do their best to supply our needs, the matter would not call for further discussion, but I submit that such information as we have goes to show that great progress has been made under difficult circumstances, and that, in respect of these necessary tools of our profession, there is no good reason why we should not make ourselves self-supporting. So far as laboratory glassware is concerned, the Special Purposes Committee have received a good many expressions of satisfaction, and, for some time past, very few complaints; and, so far as porcelain is concerned, so great has been the progress made that the British ware now obtainable compares very favourably, both in quality and in price, with that imported from Gerany and elsewhere.

The supplies of British Analytical Reagents are, generally speaking, very good indeed, and, as an example of the enterprise which has been shown by British manufacturers in connection with the supply of chemicals required for research purposes, it may be mentioned that more than two thousand British-made substances are now obtainable, and that the list is being daily extended.

I might perhaps venture to suggest that, when comparison is made between British-made glassware, porcelain and chemicals, and similar articles of foreign origin, such comparison should be between British articles known to be of recent manufacture, and the corresponding imported articles of post-war, and not of pre-war origin.

This matter is still receiving the very careful consideration of the Special Purposes Committee and of the Council, and it is hoped that much good may result from the deliberations of the Committee which has just been formed under the chairmanship of Sir Joseph Petavel, Director of the National Physical Laboratory. That Committtee, which is a very representative one, will deal with the standardisation of volumetric apparatus, and of bench-blown and furnace-blown scientific glassware, as well as with the chemical and physical properties of glass. The bringing together in friendly discussion of those who manufacture the apparatus, those who use it, and those on whom rests the responsibility of testing and certifying its accuracy, should tend to clear away many misunderstandings, and to facilitate fruitful co-operation.

Turning now for a few moments to what I may describe as the more purely domestic activities of the Institute, I would like to refer with especial pleasure to the resumption of the lectures, and to congratulate the lectures and library Committee on

having provided two such interesting and instructive discourses as that by Dr. E. J. Russell on "Modern Applications of Chemistry to Crop Production," and that by Mr. Ballantyne on "Chemists and the Patent Laws." Both these lectures were greatly appreciated on the occasions of their delivery, and I am confident that in the form of additions to the Institute's series of monographs, they will be found very useful, not only by our younger members, but also by many of our Fellows in practice.

I am informed that our library is increasingly used by our members and students, and I am also glad to have the opportunity of referring to the arrangement made with the Chemical Society, under which our members have the use of the library at Burlington House. That this privilege is greatly appreciated is shown by the records kept by the Society's librarian, and I think we shall all agree that the contribution which we make to the Society is money well spent. Whatever views we may hold in regard to the advantages or disadvantages attaching to the existence of a number of independent chemical societies, we must agree that there is often avoidable duplication of activities, accompanied by unnecessary expenditure, both of energy and of means. The formation of a truly representative library, devoted to chemistry and allied subjects, must therefore commend itself to us all. Small collections of chemical books—hardly to be dignified by the word "libraries"—must exist for reasons of convenience, and I have already referred to our own, which is chiefly intended for the use of our students and examination candidates, but it is obviously desirable, in the interests of chemists and of chemistry, that at least one great and comprehensive collection should be made, and for this important function the Chemical Society is best fitted and clearly indicated. I hope that our Treasurer, who, I have reason to know, is quite sympathetic, will not think that I am trenching upon his domain, if I say that I trust that our contributions will be as liberal as the state of our finances may permit. May I also express the hope that the existence of the privilege of using the Society's library will not have the effect of deterring any members of the Institute from seeking admission to the Society, and from helping to further by every means in their power the great work which it is doing.

I feel very strongly that one of the wisest and most statesmanlike steps ever taken by the Institute was the formation of the local sections. Not only had this the effect of putting the government of the Institute on a more truly representative basis, and of enabling the Council to keep more closely in touch with the views and with the needs of our members, wherever resident, but it stimulated—as perhaps nothing else could have done—the multifarious activities of the Institute, and gave substantial expression to the fact set forth in our title—and of which we may well be proud—that we are in very truth the Institute of Chemistry of Great Britain and Ireland. A reference to our *Journal* will suffice to show the great variety of subjects debated at the sectional meetings, and scarcely a Council meeting passes without some correspondence from one or more of the sections raising matters needing discussion in the interests of the profession as a whole.

The election of Members of Council is this year conducted under the new bylaws, and for the first time in the history of the Institute we have a directly competitive ballot. The new system is in accord with the views expressed by the local sections, and is designed to give to the main body of our members a more direct voice in the choice of the Council. Time will show how this system works in practice, but of this I am convinced, that whatever may be the result of the ballot this year, we shall have a strong and representative Council, and one which will devote itself actively and conscientiously to the work before it.

I may, perhaps, just remind you that the district members of Council returned in January sit on terms of equality with the General Members of Council, and have an equal voice in all that concerns the working and the welfare of the Institute. Our members have always regarded it as an honour and a privilege to serve the Institute in any official capacity, and many of us know how whole-heartedly they have thrown themselves into the work, and how freely they have given of their often very limited leisure.

As President, I have perhaps had an exceptional opportunity of witnessing the readiness with which men, already heavily burdened with affairs, have responded to very onerous demands upon their services in the interests of the Institute, and one need not fear for the future of a profession

which numbers so many of such men within its ranks.

To the Honorary Treasurer, I have already expressed my sense of indebtedness, and I desire to offer my warmest thanks to the Vice-Presidents, Members of Council, Chairmen of Committees and others, who have done so much to lighten my labours, and to make my year of office a very happy one.

To Professor Morgan and to Mr. Stubbs, both of whom retire from the office of Vice-President, our very especial thanks are due for the assiduity and devotion which they have shown to the affairs of the Institute.

To the retiring Members of Council, also, our warmest thanks are due. Some—like Mr. Watson Gray—have been astonishingly regular in their attendance, notwithstanding the large amount of valuable time which long railway journeys must have involved, and all have ungrudgingly given not only their time, but their special knowledge and experience, to the services of the Institute.

Of the work of our Committees, it is impossible to speak too highly. A glance at the report of the Council will suffice to show how many meetings have been held and how many important subjects have been dealt with. On the Nominations, Examinations and Institutions Committee falls, I need scarcely say, a very full share of hard work. Where all have worked so well, it is perhaps invidious to refer to any one member, but I feel that the Council would like me to take this opportunity of expressing to Mr. Hawkins our thanks for his continued services as Acting Chairman, at what must often have been considerable personal inconvenience.

The Legal and Parliamentary Committee, under the able Chairmanship of Mr. Ballantyne, has proved to be a most useful institution, as is shown by the action we have taken with regard to various measures before Parliament, and other matters of legal importance concerning the profession.

To Mr. Pilcher I do not know how to express my gratitude at all adequately. It is not too much to say that, without his ever-ready help, his great experience of Institute matters, placed always at my service, and his wise advice so willingly given, my occupancy of this chair would have been scarcely possible. I would also like, in this connection, to express my great personal obligation to Mr. Marlow, as well as to Miss Cawston and to the members of the office staff generally.

I am informed by the Registrar that, although we have 3,541 Fellows and Associates on our register, the number of our members known to be actually out of appointments is less than 70. Whilst our sympathy goes out to those who are thus temporarily deprived of employment, we have, I think, some reason to congratulate ourselves that the position is no worse.

Having regard to the increasing number of qualified chemists whom our universities are turning out, and at a time of almost unparalleled industrial depression, it is, I think, cause for congratulation that the percentage of unemployment is so small. I believe—at any rate, I sincerely hope—we may draw from this the comforting inference that employers are looking more and more to science to help them in overcoming technical difficulties, and in improving their manufacturing operations.

On the other hand, I would like to utter a note of warning. The chemical profession, like most other professions, is at the moment overcrowded, and the demands it makes on those who enter its ranks are very great, and are year by year becoming greater. Many parents still retain the impression that chemistry is a rapid road, if not to wealth, at least to a comfortable competency, and that it differs from the other professions in involving a much less expensive course of preparation. I think it well, therefore, that it should be known as widely as possible by all young men and women who may be considering the adoption of chemistry as a profession, that a keen love of the subject is essential to success, and that they must be prepared to face a great deal of hard and often unattractive work, and to make the very real sacrifices which a professional career inevitably involves.

I am well aware that there are exceptional persons to whom ordinary rules and considerations do not apply, but so far as the average chemical student is concerned, the course of training must be of the University character if success is to be ultimately attained, and the training will therefore make the same demands upon the financial resources of parents as medicine, the law, or any other of the learned professions. The sooner this fact is generally realised the better for all concerned.

This leads me to a matter in which I personally feel a very keen interest, and which demands the earnest co-operation of all our Fellows and Associates. I refer to the part which the Institute can and ought to take in helping the future generation of chemists, so far as they are represented by our registered students. I need not, perhaps, say that our students have not only ready access to the offices of the Institute, but that a great deal of time and kindly attention is devoted to them by the Executive officers. I feel, however, that something more than this is necessary. We have no desire to intervene in any way between teachers and their students, our object being rather to bring those students at an early stage of their career into touch with the realities of professional life. If, in doing this, we can introduce a little more of the personal element and show a little more active sympathy, it will, I am convinced, be all to the good. The local sections are doing what they can to further this aim, but I am hopeful that the Institute may be able to do even more than it has yet done to make the students feel that we are genuinely interested in their present welfare, as well as in their future success.

I should like to conclude this address, which has necessarily been of a discursive and unconnected character, on a note of optimism. Even as a separate branch of physical science, chemistry, as distinct from alchemy, is of comparatively recent birth, whilst as a profession—using that word in the sense in which it is understood to-day—it may be said to have come into existence within the lifetime of many of us in this room.

In these circumstances, the present position of our profession should inspire us with a feeling of pride and of deep satisfaction, and should have the effect of stimulating us all to increased endeavours to raise it still higher, and to that position of pre-eminence which it is surely destined to occupy.

There is scarcely a department of human activity which is not influenced more or less profoundly by the discoveries and developments of chemistry; nor is there a single individual in the community whose comfort has not been increased, and whose daily life has not been made happier—or at least, more tolerable—through the beneficent operations of the science we cultivate and profess. What discoveries in chemistry the future may hold, and in what way those discoveries may still further modify the material life of man, none can say, but I think it is not unlikely that if any distinctive term should be applied by the historian of the future to the era on which we are now entering, he will describe it as the "Age of Chemistry."

That the immediate outlook for professional chemistry is not brighter need cause no astonishment, but the present period of industrial depression will pass in time, and I feel confident that before long we shall see opening out before us a prospect such as the chemists of the past generation could never have thought possible. Of the future, I have never indeed felt any doubt, but we have it in our power as individuals to hasten or to retard the progress which we all so ardently desire to see. Remembering this—our individual responsibility—let us keep ever before us the highest professional ideals of duty and conduct, and strive to be worthy in every sense of our great calling.

GENERAL NOTES.

THE INSTITUTE OF METALS.

New Series of Lectures.

A notable feature of the forthcoming Swansea meeting of the Institute of Metals will be the inauguration of a series of annual public lectures on "Subjects of Practical Interest to those engaged in the Non-Ferrous Metals Industry." The lectures are additional to the well-known annual May lectures of the Institute of Metals, which have constituted a notable feature of the Institute's work since 1910.

Dr. R. S. Hutton, a Member of Council of the Institute, and Director of the British Non-Ferrous Metals Research Association, is to deliver the first of the new lectures, this being entitled, "The Science of Human Effort (Motion Study and Vocational Training)." The lecture will be given at 8 p.m. on Tuesday, September 19, at the Y.M.C.A., Swansea.

Tickets can be obtained from Mr. G. Shaw Scott, 36, Victoria Street, London, S.W.1, who will be glad to send particulars of Membership of the Institute to persons desirous of taking part in the subsequent

proceedings at Swansea. These include the discussion of fifteen papers on various metallurgical subjects, civic and other receptions and entertainments, visits to works and a motor tour round the Gower Peninsula, the entire meeting lasting from Tuesday, September 19th, to Friday, September 22nd, and constituting an excellent opportunity of combining instruction with pleasure.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.

Engineer Vice-Admiral Sir George Goodwin, K.C.B., late Engineer-in-Chief of the Fleet, and Dr. James Colquhoun Irvine, C.B.E., F.R.S., Vice-Chancellor and Principal of St. Andrews University, have been appointed by an Order of Council dated the tenth day of August, 1922, to be members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

SELENIUM SALTS.

V. Lenher.

Two further publications by this author described the properties of seleniom oxychloride and selenium oxybromide (*J. Am. Chem. Soc.*, 1922, p. 1664, 1668). In studying the oxychloride it is important to have the salt free from even traces of water, as if such are present, quite different results will be obtained, *e.g.*, increased conductivity. A good method is to treat dry selenium dioxide and fused selenium with dry chlorine. Dry selenium dioxide, prepared by burning the metal in oxygen, very rapidly absorbs atmospheric moisture. To detect traces of moisture in the oxychloride, a little of the sample is treated with perfectly dry cobalt carbonate, when the pink colour of the latter will turn blue. Precautions hence to be taken to prevent absorption of water from the air during the test. When perfectly dry, the oxychloride is without action on the dry carbonates of Ca, Sr, Cu, Ni, Co, Fe. With $BaCo_3$ and $MgCO_3$ carbon dioxide is slowly evolved. Sodium and potassium carbonates rapidly give off CO_2. The author states that selenium oxychloride acts as an oxidising acid chloride, both oxidising and chlorinating. Selenium oxybromide can be prepared by brominating the theoretical amounts of pure dry selenium dioxide and fused selenium, the necessary bromine be added to the flask through a tap funnel and atmospheric moisture being excluded by fitting a calcium bromide tube to the flask also. The flask is kept at 0°C to prevent loss of bromine. The contents of the flask are then gently warmed to dissolve all the dioxide. The oxybromide is a reddish yellow solid M.P. 41.5 to 41.7° C., B.P. 217° C. at 740 mm. with decomposition. It readily decomposes on even slight heating. Its density at 50° C. is 3.38, and electrical conductivity at 45°50° C., 6 × 10 . It is hydrolysed by water to selenious and hydrobromic acids. In chemical reactions it is dised and brominated.—(*Journal American Chemical Society.*)

NOTE ON THE PICOLINOYLAMINO-ANTHRAQUINONES.

By E. de Barry Barnett, B.Sc., F.I.C.

The α-benzoylaminoanthraquinones have marked tinctorial properties, and several compounds of this nature have been placed on the market as dyes, *e.g.*, Algol Yellow W.G. (α-benzoylaminoanthraquinone). All these compounds are completely insoluble in water, and are used as vat dyes, the dye-bath being prepared in the usual manner by means of an alkaline solution of sodium hydrosulphite, and the colour subsequently developed by exposing the yarn to the air.

It seemed of interest to ascertain if the introduction of a strongly basic group into the molecule would lead to the formation of water-soluble derivatives that would be capable of dyeing on a tannin mordant, and with this object in view α-picolinoylaminoanthraquinone was prepared, as it was hoped that subsequent treatment with an alkyl halide would lead to a soluble quaternary (pyridinium) salt. This hope was not realised as the picolinoylamino compound shows no tendency to combine with alkyl halides. For the sake of comparison the β-picolinoylamino compound was also prepared, and was found to differ from the deep yellow α-isomer by being almost colourless. This difference in colour seems to be common to all the acylamino-anthrakuinones, and it is only the α-compounds which have tinctorial properties which are of any value.

α-Picolinoylaminoanthraguinone. Picolinic acid hydrochloride (5.3 grams) was boiled under reflux with 20 grams of thionyl chloride, the condenser being closed by means of a calcium chloride tube to exclude atmospheric moisture. After about 2½ hours' complete solution had taken

place, and the excess of thionyl chloride was then removed by distillation at 12 mm. pressure from a tepid water bath. To the crude picolinoyl chloride thus obtained a solution of 5 grams of α-aminoanthraquinone in 100 cc. of tetrachlorethane was added, and the whole heated under reflux on the water bath for an hour. During this heating a certain amount of black resinous matter separated, and this was removed by filtering the hot solution. The filtrate was cooled to about 50°, and then diluted with its own volume of alcohol. After complete cooling, the yellow precipitate was collected and washed first with alcohol and then with ether. It was purified by recrystallisation from boiling pyridine, and after washing with ether was dried in a vacuum desiccator over concentrated sulphuric acid. (Found: N = 8.30, $C_{20}H_{12}O_3N_2$ requires N = 8.54 per cent.). α-Picolinoylaminoanthraquinone forms a deep yellow crystalline powder which melts and decomposes at 282-284°. On alkaline reduction it forms a red vat, but reduction takes place slowly and with considerable difficulty.

β-Picolinoylaminoanthraquinone. The preparation was carried out as described above, but no resinous matter separated. The tetrachlorethane solution was, therefore, cooled without filtration and the yellow precipitate collected, dilution with alcohol being unnecessary. After washing with ether the compound was purified by recrystallisation from pyridine. (Found: C = 73.6, H = 3.86. $C_{20}H_{12}O_3N_2$ requires C = 73.2, H = 3.70 per cent.).

β-Picolinoylaminoanthraquinone is almost colourless, and melts at 257-258°. After drying in a vacuum desiccator it takes up an electric charge with remarkable ease, so much so, in fact, before weighing it out for analysis it was found necessary to make the powder into tablets.

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Jewry St., Aldgate, London, E.C.3.

The Science Reports of the Tôhoku Imperial University, Japan, contain a valuable paper by Junzô Okubo on the "Lanthanum Violet Bands and the Associated Lines." The material used was a specimen of nitrate prepared by Kurlbaum, inserted into a rod of Acheson Graphite. The spectroscopic apparatus was a large Rowland Concave Grating, "Ilford" or "Seed No. 27" plates were used. A table of wave lengths is given and an accuracy of ± 0.007 Å is claimed for the measurements.

In the summary it is stated that "The wave lengths of the edges of the lanthanum violet bands are measured in a new international scale, and the opinion is confirmed that each band is of double structure, and that some of them have been missed by previous investigators.

"By introduction of the quanta theory the bands are explained as due to molecular rotation caused by line emissions, the connections being the double structure of the edges of bands necessary in consequence of the same nature of the original lines."

New Patents.

THIS list is specially compiled for *Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

21914—Alexander, A. E.—Synthetic resins, and process of making same. August 11.

21507—Babcock & Wilcox, Ltd.—Furnaces. August 8.

21717.—Farbwerke vorm. Meister, Lucius, & Bruning.—Manufacture of thiohydrins. August 9.

22006—Farbwerke vorm. Meister, Lucius, & Bruning.—Manufacture of alkylated acids and derivatives thereof. August 12.

21738—Hansgirg, F.—Electrolysis of zinkiferous materials. August 9.

21824—Marcotte, P. L. G.—Processes for utilization of luminescent and catalytic substances. August 10.

Specifications Published This Week.

160427—Pacz. A.—Method of producing high temperatures and the use thereof for reducing refractory oxides.

183527—Nesfield, A. C.—Means for desulphurising oils.

183629—Anderson, D. G., and Maclaurin, R.—Preparation of synthetic resins.

165788—Adler, Dr. R.—Process for the manufacture of decolourising-charcoal of high activity.

Abstract Published This Week.

Sulphur Sulphides.—Patent No. 181984.—A new process for preparing Sulphur Sulphides has been devised by Mr. B. Hunt, of 16, South St., London. Sulphur in a pure state is recovered from an aqueous emulsion in which it occurs with gangue or other earthy matter by heating under pressure in an autoclave to a temperature above the melting-point of sulphur, but not exceeding 165° C., the emulsion being agitated. Under these conditions the sulphur melts and may be separated by gravity from the aqueous liquid, the gangue, &c., remaining in suspension. The process may be applied to the mixture of sulphur and "flue dust" obtained in the treatment of certain metallurgical gases. If, in addition to sulphur and gangue, metallic sulphides are present in the emulsion, they coalesce with the sulphur (which may be added if the amount originally present is insufficient) when the latter is melted as described above, the gangue remaining in suspension as before.

Messrs. Rayner & Co. will obtain printed copies of the published specifications, and forward on

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THE PRESIDENTIAL ADDRESS.

Some Aspects of Animal Mechanism.

By Professor Sir C. S. Sherrington, G.B.E., Sc.D., D.Sc., LL.D., Pres.R.S., President of the Association.

(*Continued from Page* 133.)

Simple nerve impulses, their summations and interferences, seem the one uniform office of the nerve-system in its non-mental aspect. To pass from a nerve impulse to a psychical event, a sense-impression, percept, or emotion is, as it were, to step from one world to another and incommensurable one. We might expect, then, that at the places of transition from its non-mental to its mental regions the brain would exhibit some striking change of structure. But no; in the mental parts of the brain still nothing but the same old structural elements, set end to end, suggesting the one function of the transmission and collision of nerve impulses. The structural inter-connections are richer, but that is a merely quantitative change.

I do not want, and do not need, to stress our inability at present to deal with mental actions in terms of nervous actions, or *vice versa*. But facing the relation borne in upon us as existent between them, may we not gain some further appreciation of it by reminding ourselves even briefly of certain points of contact between the two? Familiar as such are I will merely mention rather than dwell upon them.

One is the so-called expression of the emotions. The mental reaction of an emotion is accompanied by a nervous discharge which is more or less characteristic for each several type of emotion, so that the emotion can be read from its bodily expression. This nervous discharge is involuntary, and can affect organs, such as the heart, which the will cannot reach. Then there is the circumstance that the peculiar ways and tricks of the nervous machinery as revealed to us in the study of pure reflex reactions repeat themselves obviously in the working of the machinery to which mental actions are adjunct. The phenomenon of fatigue is common to both, and imposes similar disabilities on both. Nervous exhaustion and mental exhaustion mingle. Then, as offset against this disability, there exists in both the amenability to habit formation, mere repetition within limits rendering a reaction easier and readier. Then, and akin to this, is the oft-remarked trend in both for a reaction to leave behind itself a trace, an engram, a memory, the reflex engram, and the mental memory.

How should inertia and momentum affect non-material reactions? Quick though nervous reactions are, there is always easily observed delay between delivery of stimulus and appearance of the nervous end effect; and there is always the character that a reaction once set in motion does not cease very promptly. Just the same order of lag and overrun, of want of dead-beat character, is met in sense-reactions. The sensation outlives the light which evoked it and for longer the stronger the reaction. Just so the reflex after-discharge persists after the stimulus is withdrawn, and subsides more slowly the stronger the reaction. The times in both are of the same order. Again, a reflex act which contracts one muscle commonly relaxes another. Even so along with rise of sensation in one part of the visual field commonly occurs lapse of sensation in another. And the stoppage is in both by inhibition, that is to say, active. Then again, two lights of opposite colour falling simultaneously and correspondingly on the two retinæ will, according to their balance, fuse to an intermediate tint or see-saw back and forth between the one tint and the other. Just similarly a muscle impelled by two reflexes, one tending to contract it, the other to relax it, will according to the balance of these respond steadily with an intensity, a compromise between the two, or see-saw rhythmically from extreme to extreme of the two opposite influences.

Reflex acts commonly predispose to their opposites. So similarly the visual impression of one colour predisposes to that of its opposite. Again, the *position* of the stimulated sensual point acts on the mind—hence the light seen or the pain felt is referred to some *locus* in the *mind's* space-system. Just similarly the reflex machinery directs, for instance, the limb it moves towards the particular spot stimulated. And such

spots in the two processes, mental and non-mental, correspond.

Characteristic of the nervous machinery is its arrangement in what Hughlings Jackson called "levels," the higher levels standing to the lower not only as drivers but also as restrainers. Hence in disease underaction of one sort is accompanied by overaction of another. Thus in the arm affected by a cerebral stroke, besides loss of willed—that is higher level—power in the finger muscles, there is in other muscles involuntary overaction owing to escape of lower centres from control by the higher which have been destroyed. So similarly with the sensory effects. Of skin sensations some are painful and some not, for instance touch. The seat of the latter is of higher level, cortical; of the former lower, sub-cortical. When cerebral disease breaks the path between the higher and the underlying level a result is impairment of touch sensation but heightening of pain sensation in the affected part. The sensation of touch, as Dr. Head says, restrains that of pain.

Thus features of nervous working resemble over and over again mental. Is it mere metaphor when we speak of mental attitudes as well as bodily? Is it mere analogy to liken the warped attitude of the mind in a psychoneurotic sufferer to the warped attitude of the body constrained by an internal potential pain? Again, some mental events seem spontaneous; in the nervous system some impulses seem generated automatically from within.

It may be said of all these similarities of time-relation and the rest between the ways of the nervous system and such simpler ways of mind as I here venture on, that they exist because the operations of the mental part of the nervous system communicate with the exterior only through the non-mental part as gateway. That there, then, the features of the nerve-machinery are impressed on the mind's working. But that suggestion forgets that the higher and more complex the mental process, the longer the time-lag, the more incident the fatigue, the more striking the memory character, and so on.

Yet all this similarity does but render more succinct the old enigma as to the nexus between nerve impulse and mental event. In the proof that the working of the animal mechanism conforms with the first law of thermodynamics, can one say that psychical events are evaluated in the balance sheet drawn up? And, on the other hand, Mr. Barcroft and his fellow-observers in their recent physiological exploration of life on the Andes at 14,200 ft. noted that, as well as were their muscles, their arithmetic there was at a disadvantage. The low oxygen pressure militated against both. Indeed we all know that in any of us a few minutes without oxygen, or a few more with chloroform, and the psychical and the nervous events will lapse together. The nexus between the two sets of events is strict. But for comprehension of its nature we still require, it seems, comprehension of the unsolved mystery of the how of life itself. A shadowy bridge between them may lie perhaps in the reflection that for the observer himself the physical phenomena he observes are in the last resort psychical.

The practical man has to accept nervous function as a condition for mental function without breaking his heart over ignorance of their connection. The doctor, the laywer, and we all, accept it. We know that with structural derangement or destruction of certain parts of the brain goes mental derangement or defect, while derangement or destruction of other parts of the nervous system is not so accompanied. Decade by decade the connection becomes more ascertained between certain mental performances and certain cerebral regions. Certain impairments of ideation as shown by forms of incomprehension of language or of familiar objects can help to diagnose for the surgeon as to what part of the brain a tumour is compressing; and the tumour gone the mental disabilities pass. So similarly those who, as Professor Elliott Smith and Sir Arthur Keith, recast the shape of the cerebrum from the cranial remains of prehistoric man can outline for us something of his mentality from examination of the relative development of the several brain regions, using a true and scientific phrenology.

Could we look quite naively at the question of a seat for the mind within the body we might perhaps suppose it diffused there, not localised in any one particular part at all. That it is localised and that its localisation is in the nervous system—can we attach meaning to that fact? The nervous system is that bodily system whose special office from its earliest appearance onward throughout evolutionary history has been more and more to weld together the body's component parts into one consolidated mechanism reacting as a unity to the changeful world about it. It more than any other system has constructed out of a

collection of organs an individual of unified act and experience. It represents the acme of accomplishment of the integration of the animal organism. That it is in this system that mind, as we know it, has had its beginning, and with the progressive development of the system has step for step developed, is surely significant. So is it that in this system the portion to which mind transcendently attaches is exactly that where are carried to their highest pitch the nerve-actions which manage the individual as a whole, especially in his reactions to the external world. There, in the brain, the integrating nervous centres are themselves further compounded, inter-connected, and re-combined for unitary functions. The cortex of the forebrain is the main seat of mind. That cortex with its twin halves corresponding to the two side-halves of the body, is really a single organ knitting those halves together by a still further knitting together of the nervous system itself. The animal's great integrating system is there still further integrated. And this supreme integrator is the seat of all that is most clearly inferable as the animal's mind. As such it has spelt biological success to its possessors. From small beginnings it has become steadily a larger and larger feature of the nervous system, until in adult man the whole rest of the system is relatively dwarfed by it. Not without significance, perhaps, is that in man this organ, the brain cortex, bifid as it is, shows unmistakable asymmetry. Man is a tool-using animal, and tools demand asymmetrical, though attentive and therefore unified, acts. A nervous focus unifying such motor function will, in regard to a laterally bipartite organ, tend more to one half or the other. In man's cerebrum the preponderance of one-half, namely, the left, over the other may be a sign of unifying function.

It is to the psychologist that we must turn to learn in full the contribution made to the integration of the animal individual by mind. But each of us can, without being a professed psychologist, yet recognise one achievement in that direction which mental endowment has produced. Made up of myriads of microscopic cell-lives, individually born, feeding and breathing individually within the body, each one of us nevertheless appears to himself a single entity, a unity experiencing and acting as one individual. In a way the more far-reaching and many-sided the reactions of which a mind is capable the more need, as well as the more scope, for their consolidation to one. True, each one of us is in some sense not one self, but a multiple system of selves. Yet how closely those selves are united and integrated to one personality. Even in those extremes of so-called double personality one of their mystifying features is that the individual seems to himself at any one time wholly either this personality or that, never the two commingled. The view that regards hysteria as a mental dissociation illustrates the integrative trend of the total healthy mind. Circumstances can stress in the individual some perhaps lower instinctive tendency that conflicts with what may be termed his normal personality. This latter, to master the conflicting trend, can judge it in relation to his main self's general ethical ideals and duties to self and the community. Thus intellectualising it, he can destroy it or consciously subordinate it to some aim in harmony with the rest of his personality. By so doing there is gain in power of will and in personal coherence of the individual. But if the morbid situation be too strong or the mental self too weak, instead of thus assimilating the contentious element the mind may shun and, so to say, endeavour to ignore it. That way lies danger. The discordant factor escaped from the sway of the conscious mind produces stress and strain of the conscious self; hence, to use customary terminology, dissociation of the self sets in, bringing in its train those disabilities, mental or nervous or both, which characterise the sufferer from hysteria. The normal action of the mind is to make up from its components one unified personality. When we remember the manifold complexity of composition of the human individual, can we observe a greater instance of solidarity of working of an organism than that presented by the human individual intent and concentrated, as the phrase goes, upon some higher act of strenuous will? Physiologically the supreme development of the brain, psychologically the mental powers attaching thereto, seem to represent from the biological standpoint the very culmination of the integration of the animal organism.

The mental attributes of the nervous system would be, then, the coping-stone of the construction of the individual. Surveyed in their broad biological aspect, we see them carrying integration even further still. They do not stop at the individual; they proceed beyond the individual; they

integrate from individuals communities. When we review, as far as we can judge it, the distribution of mind within the range of animal forms, we meet two peaks of its development—one in insect life, the other in the vertebrate, with its acme finally in man. True, in the insect the type of mind is not rational but instinctive, where as at the height of its vertebrate development reason is there as well as instinct. Yet in both one outcome seems to be the welding of individuals into societies on a scale of organisation otherwise unattained. The greatest social animal is man; the powers that make him so are mental. Language, tradition, instinct for the preservation of the community, as well as for the preservation of the individual. Reason actuated by emotion and sentiment and controlling and welding egoistic and altruistic instincts into one broadly harmonious, instinctive-rational behaviour. Just as the organisation of the cell-colony into an animal individual receives its highest contribution from the nervous system, so the further combining of animal individuals into a multi-individual organism, a social community, merging the interests of the individual in the interests of the group, is due to the nervous system's crowning attributes, the mental. That this integration is still in process, still developing, is obvious from the whole course of human pre-history and history. The biological study of it is essentially psychological; it is the scope and ambit of social psychology. Not the least important form of social psychology is that relatively new one, of which the President of the Psychology Section at this meeting is a foremost authority and exponent, namely, that dealing with the stresses and demands that organised industry makes upon the individual as a unit in the community of our day, and with the readjustments it asks from that community.

To resume, then, we may, I think, conclude that in some of its aspects animal life presents to us mechanism the how of which, despite many gaps in our knowledge, is fairly explicable. Of not a few of the processes of the living body, such as muscular contraction, the circulation of the blood, the respiratory intake and output by the lungs, the nervous impulse and its journeyings, we may fairly feel from what we know of them already that further application of physics and chemistry will furnish a competent key. We may suppose that in the same sense as we can claim to-day that the principles of working of a gas-engine or an electro-motor are comprehensible to us, so will the bodily working in such mechanisms be understood by us, and indeed are largely so already. It may well be possible to understand the principle of a mechanism which we have not the means or skill ourselves to construct. We cannot construct the atoms of a gas-engine. But, turning to other aspects of animal mechanism, such as the shaping of the animal body, the conspiring of its structural units to compass later functional ends, the predetermined natural term of existence, these, and their intimate mechanism, we are, it seems to me, despite many brilliant inquiries and inquirers, still at a loss to understand. The steps of the results are known, but the springs of action still lie hidden. Then again, the how of the mind's connection with its bodily place seems still utterly enigma. Similarity or identity in time-relations and in certain other ways between mental and nervous processes does not enlighten us as to the actual nature of the connection existent between the two. Advance in biological science does but serve to stress further the strictness of the nexus between the two.

Great differences of difficulty therefore confront our understanding of different aspects of animal life. Yet the living creature is fundamentally a unity. In trying to make the how of an animal existence intelligible to our imperfect knowledge we have for purposes of study to separate its whole into part-aspects and part-mechanisms, but that separation is artificial. It is as a whole, a single entity, that the animal, or for that matter the plant, has finally and essentially to be envisaged. We cannot really understand its one part without its other. Can we suppose a unified entity which is part mechanism and part not? One privilege open to the human intellect is to attempt to comprehend, not leaving out of account any of its properties, the how of the living creature as a whole. The problem is ambitious, but its importance and its reward are all the greater if we seize and we attempt the full width of its scope. In the biological synthesis of the individual it regards mind. It includes examination of man himself as acting under a biological trend and process which is combining individuals into a multi-individual organisation, a social organism surely new in the history of the planet. For this biological trend and

process is constructing a social organism whose cohesion depends mainly on a property developed so specifically in man as to be, broadly speaking, his alone, namely, a mind actuated by instincts but instrumented with reason. Man, often Nature's rebel, as Sir Ray Lankester has luminously said, can, viewing this great supra-individual process, shape even as individual h's course comformably with it, feeling that in this iustance to rebel would be to sink lower rather than to continue his own evolution upward.

BRITISH ASSOCIATION.

Section B.—Chemistry.

Part I.—THE ORGANISATION OF RESEARCH.

Address by Principal J. C. Irvine, C.B.E., D.Sc., LL.D., F.R.S.

President of the Section.

I am deeply sensible of the honour done to me in electing me to this chair, and am well aware of my own unworthiness to occupy the position Nevertheless, I feel that there is something appropriate in the choice which brings once more into close relationship the University of St. Andrews and the British Association. You will forgive me if, for the moment, my thoughts are focussed not so much on the subject assigned to our Section as on the origin and nature of this annual gathering of scientists.

The British Association was the product of an age rather than the inspiration of any one man, yet of those who first gave practical effect to the movement which has spread scientific learning and has bound its devotees in a goodly fellowship there was no more eager spirit than Sir David Brewster. It is not an exaggerated claim that it was he who founded the British Association. One may trace his enlightened action to a desire to combat the apathy and distrust shown by the Government of his day towards scientific work and even scientific men. Only in the historical sense can I claim any relationship with Brewster. It is my privilege to occupy the Principalship he once held, and I cannot escape from the thought that the daily tasks now mine were once his.

It is thus inevitable that to-day a name often in my mind should spring once more into recollection, especially as my distinguished predecessor was present at the first Hull meeting in 1853, when he contributed two papers to Section A. Chemists should be among the first to pay grateful tribute to Brewster's efforts on behalf of science, and I propose, therefore, to include in my address a review of the position scientific chemistry has won since his day in public and official tstimation. Moreover, at the express suggestion of some of our members whose opinions cannot be disregarded, I am induced to add the consideration of the new responsibilities chemists have incurred now that so many of Brewster's hopes have been realised. These were recently submitted by me to another audience and, through the medium of an article in *Nature*, are possibly known to you already, but I agree with my advisers that their importance warrants further elaboration and wider discussion.

It would be idle to recall the lowly position of chemistry as an educative force in this country, or to reconstruct the difficulties with which the scientific chemist was confronted during the first thirty years of the nineteenth century. Present difficulties are serious enough, and press for all our attention, without dwelling unduly on troubles of the past. But we must at least remember that in the early days of the British Association "schools" of chemistry were in their infancy, and that systematic instruction in the science was difficult to obtain. Another point of fundamental importance which has to be borne in mind is that the masters of the subject were then for the most part solitary workers.

It is difficult for us, looking back through the years, to realise what it must have meant to search for truth under conditions which were discouraging, if not actually hostile. Yet, although his labours were often thankless and unrewarded, the chemist of the time was probably a riper philosopher and a finer enthusiast than his successor of to-day. He pursued his inquiries amidst fewer distractions, and in many ways his lot must have been happy, save when tormented by the thought that a subject so potent as chemistry in developing the intellectual and material welfare of the community should remain neglected to an extent which to us seems incredible.

Public sympathy was lacking, Government support was negligible or grudgingly bestowed, and there was little or no cooperation between scientific chemistry and

industry. As an unaided enthusiast the chemist was left to pursue his way without the stimulus, now happily ours, which comes from the feeling that work is supported by educated and enlightened appreciation.

Let me quote from one of Faraday's letters now in my possession and, so far as I can trace, unpublished. Writing to a friend immediately before the foundation of the British Association, he relates that a manufacturer had adopted a process *developed in the course of an investigation* carried out in the Royal Institution. The letter continues: "He" (the manufacturer) "writes me word that, having repeated our experiments, he finds the product very good, and as our information was given openly to the world he, as a matter of compliment, has presented me with some pairs of razors to give away." If ever there was a compliment which could be described as empty, surely this was one; yet the letter gives the impression that Faraday himself was quite content with his reward.

It is perhaps unfair to quote Faraday as a type, for few men are blessed with his transparent simplicity of character, but there is obviously a great gulf fixed between the present day and a time when a debt of honour could be cancelled in such a manner. A little reflection will show that the British Association has played a useful part in discrediting the idea that because so much scientific discovery is given "openly to the world," those who profit by such discoveries should be absolved from their reasonable obligations. Even where scientific workers do not expect or desire personal reward, the institutions which provide them with their facilities are often sorely in need. The recognition, not yet complete, but more adequate than once was the case, that the labourer is worthy of his hire represents only one minor change which the years have brought.

An even greater contrast, embodying more important principles, is found in the changed attitude of the State towards scientific education and discovery. Remember Brewster's fond hope that, by means of our Association, the whole status of science would be raised, and that a greater measure of support and encouragement would be received from the Government. How eagerly the venerable physicist must have listened to the Presidential Address delivered at the twenty-third meeting of the Association assembled in Hull for the first time. It dealt with many problems familiar to him. No doubt he followed with keen interest the account of the observations on Nebulæ made with Lord Rosse's telescope, and appreciated the references to the work of Joule and Thomson. The address was a masterly synopsis of scientific progress, but from time to time a new note steals in. There is a significant reference to a consultation with the Chancellor of the Exchequer, another to a conversation with Mr. Gladstone, and a third to a working arrangement concluded with the Admiralty. These would fall sweetly on Brewster's ear, and he would cordially approve of the report of our Parliamentary Committee which had established sympathetic contact with the House of Commons. He could not fail to be impressed with the changes a few years had brought.

Let us bridge the further gap of sixty-nine years which separates us from that day. The contrast is amazing, and once more we can trace the steady, persistent influence of the British Association in bringing about what is practically a revolution in public and official opinion. We have learned many lessons. The change has come suddenly, but it was not spontaneous. Many years had to be spent in disseminating the idea that research is a vital necessity, and toward this end Presidents of our Association have not hesitated, year after year, to add the weight of their influence and eloquence. It was courageous of them to do so. I would refer you particularly to the forcible appeals made by Sir James Dewar at Belfast and Sir Norman Lockyer at Southport, when the plea for more research was laid before the Association, and thus found its way by the most direct channel to the Press and to the public. No doubt many other factors have played a part in creating a research atmosphere in this country, but the steady pressure exerted by the British Association is not the least important of these influences.

The principles of science are to-day widely spread; systematic scientific training has found an honourable place in the schools and in the colleges; above all, there is the realisation that much of human progress is based on scientific inquiry, and at last this is fostered, and, in part, financed as a definite unit of national educational policy. Public funds are devoted to provide

facilities for those who are competent to pursue scientific investigations, and in this way the State, acting through the Department of Scientific and Industrial Research, has assumed the double responsibility of providing for the advancement of knowledge and for the application of scientific methods to industry. Scientists have been given the opportunities they desired, and it remains for us to justify all that has been done. We have this morning glanced briefly at the painful toil and long years of preparation; now it falls to us to sow the first crop and reap the first harvest.

Thanks to the wisdom and foresight of others, it has been possible to frame the Government policy in the light of the experience gained with pre-existing research organisations. The pioneer scheme of the kind is that administered by the Commissioners of the 1851 Exhibition, who since 1890 have awarded research scholarships to selected graduates. When in 1901 Mr. Carnegie's benefaction was applied to the Scottish Universities the trustees wisely determined to devote part of the revenues to the protection of research awards which take the form of Scholarships, Fellowships, and Research Lectureships. These have proved an immense boon to Scottish graduates, and the success of the venture is sufficiently testified by the fact that the Government Research scheme was largely modelled on that of the Carnegie Trust.

In each of these organisations chemistry bulks largely, and the future of our subject is intimately connected with their success or failure. The issue lies largely in our hands. We must not forget that we are only at the beginning of a great movement, and that fresh duties now devolve upon us. It was my privilege for some years to direct the work of a Chemistry Institute, where research was organised on lines which the operation of the Government scheme will make general. If, from the very nature of things, my experience cannot be lengthy, it is at least intimate, and I may perhaps be allowed to lay before you my impressions of the problems we have to face.

Two main objectives lie before us: the expansion of useful learning and the diffusion of research experience among a selected class. This class in itself will form a new unit in the scientific community, and from it will emerge the "exceptional man" to whom, quoting Sir James Dewar, "we owe our reputation and no small part of our prosperity." When these words were uttered in 1902 it was a true saying that "for such men we have to wait upon the will of Heaven." It is still true, but there is no longer the same risk that the exceptional man will be forthcoming, and you must not imagine that I am regarding him merely as one who will occupy a University Chair. He will be found more frequently in industry, where his function will be to hand on the ideas inspired by his genius to the ordinary investigator.

I have no intention of wearying you by elaborating my views on the training required to produce these different types. My task is greatly simplified if you will agree that the first step must be systematic experience in pure and disinterested research, without any reference to the more complicated problems of applied science. This is necessary, for if our technical research is to progress on sound lines the foundations must be truly laid. I have no doubt as to the prosperity of scientific industries in this country so long as we avoid hasty and premature specialisation in those who control them. We may take it that in the future the great majority of expert chemists will pass through a stage in which they make their first acquaintance with the methods of research under supervision and guidance. The movement is already in progress. The Government grants are awarded generously and widely. The conditions attached are moderate and reasonable, and there is a rush to chemical research in our colleges. Here, then, I issue my first note of warning, and it is to the professors. It is an easy matter to nominate a research student; a research laboratory comfortably filled with workers is an inspiring sight, but there are few more harassing duties than those which involve the direction of young research chemists. No matter how great their enthusiasm and abilities, these pupils have to be trained, guided, inspired, and this help can come only from the man of mature years and experience. I am well aware that scorn has been poured on the idea that research requires training. No doubt the word is an expression of intellectual freedom, but I have seen too many good investigators spoiled and discouraged through lack of this help to hold any other opinion than that training is necessary. I remember, too, years when I wandered more or less aimlessly down the by-paths of pointless inquiries, and I then learned to realise the necessity of economising the time and effort of others.

The duties of such a supervisor cannot be light. *He must possess versatility;* for although a "research school" will doubtless preserve one particular type of problem as its main feature, there must be a sufficient variety of topics if narrow specialisation is to be avoided. Remember, also, that there can be no formal course of instruction suitable for groups of students, no common course applicable to all pupils and all inquiries. Individual attention is the first necessity, and the educative value of early researches is largely derived from the daily consultations at the laboratory bench or in the library. The responsibility of becoming a research supervisor is great, and, even with the best of good will, many find it difficult to enter sympathetically into the mental position of the beginner. An unexpected result is obtained, an analysis fails to agree, and the supervisor, out of his long experience, can explain the anomaly at once, and generally does so. If the pupil is to derive any real benefit from his difficulties, his adviser must for the moment place himself in the position of one equally puzzled, and must lead his collaborator to sum up the evidence and arrive at the correct conclusion for himself. The policy thus outlined is, I believe, sound, but it makes severe demands on patience, sympathy, and, above all, time.

Research supervision, if conscientiously given, involves the complete absorption of the director's energy and leisure. There is a rich reward in seeing pupils develop as independent thinkers and workers, but the supervisor has to pay the price of seeing his own research output fade away. He will have more conjoint papers, bnt fewer individual publications, and limitations will be placed on the nature of his work by the restricted technique of his pupils.

I have defined a high standard, almost an ideal, but there is, of course, the easy alternative to use the technical skill of the graduate to carry out the more laborious and mechanical parts of one's own researches, to regard these young workers as so many extra pairs of hands. I need not elaborate the outcome of such a policy.

There is another temptation, and that, in an institution of university rank, is for the professor to leave research training in the hands of his lecturers, selecting as his collaborators only those workers who have passed the apprenticeship stage. This, I am convinced, is a mistake. Nothing consolidates a research school more firmly than the feeling that all who labour in its interests are recognised by having assigned to them collaborators of real ability.

I am not yet done with the professor and his staff, for they will have other matters to attend to if research schools are to justify their existence and to do more than add to the bulk of our journals. In many cases it will be found that the most gifted of the young workers under their care lack what, for want of a better expression, is known as "general culture" Remember, these graduates have just emerged from a period of intensive study in which chemistry and the allied sciences have absorbed most of their attention. For their own sake and in the interests of our subject, they must be protected from the criticism that a scientific education is limited in outlook and leads to a narrow specialism. The research years are plastic years, and many opportunities may be found in the course of the daily consultations "to impress upon the student that there is literature other than the records of scientific papers, and music beyond the range of student songs." I mention only two of the many things which may be added to elevate and refine the research student's life. Others will at once occur to you, but I turn to an entirely different feature of research training, for which I make a special plea: I refer to the inculcation of business-like methods. You will not accuse me, I hope, of departing from the spirit of scholarship or of descending into petty detail, but my experience has been that research students require firm handling. Emancipated as they are from the restrictions of undergraduate study, the idea seems to prevail that these workers ought to be excused the rules which usually govern a teaching laboratory, and may therefore work in any manner they choose. It requires, in fact, the force of a personal example to demonstrate to them that research work can be carried out with all the neatness and care demanded by quantitative analysis. Again, in the exercise of their new freedom young collaborators are inclined to neglect recording their results in a manner which secures a permanent record and is of use to the senior collaborator. As a rule, the compilation of results for publication is not done by the experimenter, and a somewhat elaborate system of records has to be devised. It should be possible, twenty years after the work has been done, to quote the reasons which led to the initiation of each experiment, and to trace the

source and history of each specimen analysed, or upon which standard physical constants have been determined. I need not enter into detail in this connection beyond stating that, although a system which secures these objects has for many years been adopted in St. Andrews, constant effort is required to maintain the standard.

One of the greatest anxieties of the research supervisor is, however, the avoidance of extravaganie and waste. The student is sometimes inclined to assume a lordly attitude and to regard such matters as the systematic recovery of solvents beneath his notice. My view is that, as a matter of discipline as much as in the interests of economy, extravagant working should not be tolerated. There is naturally an economic limit where the time spent in such economies exceeds in value the materials saved, and a correct balance must be adjusted. It is often instrnctive to lay before a research worker an estimate of the cost of an investigation in which these factors of time and material are taken into account. As a general rule it will ge found that the saving of material is of greater moment than the loss of time. The point may not be vitally important in the academic laboratory, but in the factory, to which most of these workers eventually migrate, they will soon have the lesson thrust upon them that their time and salary bear a small proportion to costs of production.

Cou will see I have changed my warning from the professor to the student. A student generation is short. In a few years, when almost as a matter of course the hest of young chemists will qualify for the Doctor of Philosophy degree, it will he forgotten that these facilities have come to us, not as a right, but as a privilege. Those fho reap the advantages of these privileges must prove that the efforts made on their behalf have been worth while.

Looking at the position broadly, if one may criticise the research schemes of to-day, it is in the sense that the main bulk of support is afforded to the research apprentice, and the situation has become infinitely harder for the supervisor in that new and onerous tasks are imposed upon him. To expect him to undertake his normal duties and, as a voluntary act, the additional burden of research training is to force him into the devastation of late hours and overwork. The question is at once raised: Are we using our mature research material to the best advantage, and is our policy sufficiently focussed on the requirements of the experienced investigator? I think it will generally be agreed that members of the professor or lecturer class who join in the movement must he relieved in great measure of teaching and administrative work. I am decidedly of the opinion that the research supervisor must be a teacher, and must mingle freely with undergraduates, so as to recognise at the earliest possible stage the potential investigators of the future and guide their studies. To meet this necessity universities and colleges must realise that their curriculum has been extended and that staffs must he enlarged accordingly. There could then be definite periods of freedom from official duties for those who nndertake research training as an added task. Opportunities must also be given to these "exceptional men" to travel occasionally to other centres and refresh themselves in the company of kindred workers. It is evident that our universities are called upon to share the financial burden involved in a National Research scheme to a much greater extent than possibly they know.

I may perhaps summarise some of the conclusions I have reached in thinking over these questions. The first and most important is that in each institution there should be a Board or Standing Committee entrusted with the supervision of research. The functions of such a body would be widely varied and would include:—

1. The allocation of money voted specificallu from university or college funds for research expenses.

2. The power to recommend additions to the Teaching Staff in departments actively engaged in research.

3. The recommendation of promotions on the basis of research achievement.

4. The supervision of regulations governing higher degrees.

Among the more specific problems which confront this Board are the following:—

1. The creation of Research Libraries where reference works can be consulted immediately.

2. The provision of publication grants, so that where no periodical literature is available the work will not remain buried or obscure.

3. The allocation of travelling grants to enable workers to visit libraries, to inspect manufacturing processes, and to attend meetings of the scientific societies.

I have dealt merely with the fringe of the question, but would add that there is

one thing which a Research Board should avoid.

It is, I am convinced, a mistake for a governing body to call for an annual list of publications from research laboratories. Nothing could be more injurious to the true atmosphere of research than the feeling of pressure that papers must be published or the Department will be discredited.

What I have said so far may seem largely a recital of new difficulties, but they are not insurmountable, and to overcome them adds a zest to life. It would have taken too long to go more fully into details, and I have tried to avoid making my address a research syllabus, merely giving in general terms the impressions gained dering the 20 years in which the St. Andrews Research Laboratories have been in existence.

Save for the fact that I realise my audience is not confined to university teachers I would have liked to speak on some such points as these: The choice of a research student, the selection of a research subject, the writing of scientific papers. Each would demand a lengthy discussion, as would also the painful situation created when a research topic fails or a research worker proves disappointing.

I have confined myself to the first stage in the research development of the chemist. His future path may lead him either to the factory or to the lecture-room, and in the end the exceptional man will be found in the director's laboratory or in the professor's chair. However difficult these roads may prove, I feel that with the financial aid now available, supported by the self-sacrificing labours of those who devote themselves to furthering this work, he has the opportunity to reach the goal. It is the beginning of a new scientific age, and we may look forward confidently to the time when there will be no lack of trained scientific intellects to lead our policy and direct our efforts in all that concerns the welfare of the country.

(To be Continued.)

[Contribution from the Department of Chemistry, University of Wisconsin.]

SELENIUM OXYBROMIDE.

By Victor Lenher.

From the "Journal of the American Chemical Society."

The oxybromide of selenium, $SeOBr_2$, was originally prepared by Schneider.[1] It was later made by Glauser[2] who noted a few of its properties.

The various methods used for its preparation and its properties in general are closely related to those of selenium oxychloride.

Preparation.—One of the simplest and most direct procedures to assure a satisfactory product is to unite pure dioxide and pure tetrabromide of selenium.[3] To this end, we have used freshly sublimed selenium dioxide, special care being taken to obtain it as dry as possible.[4] To this is added the calculated amount of powdered fused pure selenium. The operation can be conveniently conducted in a glass flask closed by a rubber stopper carrying a dropping funnel and a tube containing freshly ignited pure calcium bromide to protect the products from atmospheric moisture. The requisite amount of pure bromine is added through the dropping funnel in small portions at a time. The heat evolved in the bromination of elementary selenium to monobromide and subsequently to tetrabromide is so great that it is advisable to chill the flask nearly to 0° in order to prevent loss of bromine. The heat evolved in bromination of the monobromide to the tetrabromide is so much less than in the production of the monobromide that the last portions of bromine can be added very rapidly. After the calculated amount of bromine has been added the mixture of tetrabromide and dioxide is gently warmed until all of the dioxide has dissolved to for moxybromide. When the selenium dioxide is finely powdered this takes place quickly, but when large crystals are used a number of hours may be required to effect complete solution.

Physical Properties.—Selenium oxybromide is a reddish-yellow solid that melts at 41.5-41.7° and boils at 217° under 740 mm. pressure with considerable decomposition. Its decomposition at even slightly elevated temperatures is so great that it has not been found practical to attempt to purify it by distillation under diminished pressure. Its density at 50° is 3.38. Its electrical conductivity, as observed by A. P. Julien in this laboratory in a modified Washburn cell using platinum electrodes

1 Schneider, Pogg. Ann., 129, 459 (1866).

2 Glauser, Z. anorg. Chem., 80, 277 (1913).

3 Lenher, Jour. Amer. Chem. Soc., 42, 2498 (1920); 33, 29 (1921); 44, 1664 (1922).

4 Ibid., p. 1664.

and working just above the melting point, 45-50°, is approximately 6×10

Selenium oxybromide is hydrolysed by water into selenious and hydrobromic acids. It dissolves readily without apparent chemical action in carbon disulfide, chloroform, benzene, toluene and xylene, and the fused material is miscible in all proportions with these solvents, as is selenium oxychloride.

Carbon tetrachloride dissolves selenium oxybromide but the fused substance is soluble to the extent of only about 6 per cent. Carbon tetrachloride and selenium oxybromide do not immediately react chemically when brought into contact, but when heated together for several days phosgene is produced in large quantities.

With the saturated aliphatic hydrocarbons there is apparently little if any chemical action. The pure hydrocarbons hexane, heptane, octane and decane are immiscible with the reagent. The lighter hydrocarbons float on melted selenium oxybromide. Similarly, melted paraffin or vaseline floats on liquid selenium oxybromide.

CHEMICAL PROPERTIES.

Selenium oxybromide is a very active chemical reagent Its deportment and activity in general much resemble those of the oxychloride. When selenium oxybromide is distilled it dissociates somewhat into selenium dioxide and tetrabromide. Heating the tetrabromide causes further decomposition into monobromide of selenium and free bromine. It is possible to distil the substance, but there is considerahle loss in the operation. Even when distilled under greatly diminished pressure there is considerable decomposition. In order, therefore, to avoid confusion of the behaviour of selenium oxybromide with the various materials studied, comparative experiments have been made with the particular snbstances and bromine.

Action on Non-Metals.—The members of the sulfur group, sulfur, selenium and tellurium, react immediately with selenium oxybromide. Sulfur even in the cold with solid selenium oxybromide liquefies in a few minutes and evolves sulfur dioxide with effervescence. Selenium dissolves in large quantities in melted selenium oxybromide forming the monobromide. Tellurium reacts in the cold but not so energetically.

White phosphorus with solid selenium oxybromide explodes violently, while red phosphorus with solid selenium oxybromide takes fire and burns with a flame.

Iodine dissolves in large quantities in selenium oxybromide, while chlorine displaces the bromine and converts it to pure selenium oxychloride. Crystalline silicon is unattacked by the reagent even at 217°. Carbon in all forms, graphite, charcoal, activated carbon and diamond are not attacked even at its boiling point by selenium oxybromide.

Action on Metals.—Selenium oxybromide reacts with most of the metals forming the bromide and selenium monobromide. Sodium reacts in the cold with selenium oxybromide with slight explosion evolving light and heat. Potassium in the cold with solid selenium oxybromide explodes violently.

Metallic mercury, arsenic, antimony, tin, bismuth, iron, calcium, copper, lead, silver, molybdenum, thallium, gold, platinum and zinc are attacked by selenium oxybromide. Zinc dust burns beautifully in selenium oxybromide, making a striking experiment. Aluminum and magnesium are only very slightly corroded by heating in a sealed tube with selenium oxybromide for a week at 100°. Chromium, cadmium, nickel, cobalt, tungsten and tantalum are not attacked when heated with selenium oxybromide in a sealed tube for 10 days to 100°.

Action on Oxides.—Selenium oxybromide reacts with certain of the oxides, such as mercuric oxide, silver oxide, lime and sodium peroxide with great energy, while arsenic trioxide, tin dioxide, tellurium dioxide, tellurium trioxide react more slowly and less energetically.

Such oxides as those of columbium, tantalum, vanadium, thorium, titanium, zirconium, uranium, and antimony are apparently unaffected even on heating in a sealed tube for a number of days to 100°. Ignited cerium oxide is only very slightly attacked.

Carbonates.—Selenium oxybromide reacts slowly and sluggishly with the carbonates of calcium, strontium, barium, magnesium, lead, copper, sodium, potassium and the alkaline bicarbonates, even when warmed. When water is present the action is, of course, vigorous. Dry cobalt carbonate is not appreciably acted upon.

Sulfides. — Arsenious, arsenic, antimonous, stannous, cadmium, zinc, bismuth, mercuris, lead, strontium, and ferrous sulfides react with selenium oxybromide, evolving heat. The metallic bromides and selenium monobromide are formed. Pyrite,

marcasite, arsenopyrite, and tetrahedrite react with selenium oxybromide with production of selenium monobromide.

Calcium Hydride, Carbide and Phosphide are only very slowly and sluggishly attacked by selenium oxybromide even on boiling.

Barium Sulfate is not acted on by selenium oxybromide nor is it rendered colloidal as is the case when brought in contact with selenium oxychloride.

Oxidizing Agents. — Potassium chlorate reacts with selenium oxybromide and bromine is evolved. When the two are gently warmed together the bromine is completely expelled in a few minutes. Potassium perchlorate does not react with selenium oxybromide.

Potassium permanganate, potassium dichromate and chromium trioxide do not react with selenium oxybromide, even on boiling.

5 Jour. Amer. Chem. Soc., 43, 32 (1921).

Action of Various Gases.—When dry air is bubbled through pure selenium oxybromide heated to 60°, bromine is gradually driven off. This is due to a primary dissociation of the oxybromide into dioxide and tetrabromide of selenium and to a secondary slow decomposition of the tetrabromide into monobromide and free bromine which is volatile. After dry air is bubbled through heated pure selenium oxybromide for several days and the resulting product treated with water, a very large amount of monobromide appears as the characteristic heavy red-brown liquid which hydrolyzes very slowy. Indeed, the slow hydrolysis of selenium monobromide is one of its striking featnres. Selenium monobromide is only slowlp decomposed by boiling water into elementary selenium, selenious and hydrobromic acids, while when allowed to stand with excess of cold water some of the liquid selenium monobromide remains undecomposed at the end of several days.

Dry Sulfur Dioxide and Dry Carbon Monoxide do not react with fused selenium oxybromide. *Hydrogen Sulfide* causes slight decomposition.

Hydrocarbons.—The saturated aliphatic hydrocarbons are only slowly attacked by selenium oxybromide at a high temperature.

The unsaturated aliphatic hydrocarbons react with selenium oxybromide with great energy. Amylene, turpentine and isoprene react with great violence with selenium oxybromide.

The aromatic hydrocarbons such as benzene, toluene, and xylene form physical mixtures with selenium oxybromide from which the hydrocarbons can be recovered by hydrolysis of the mixture with water.

Naphthalene, anthracene, phenanthrene and retene dissolve readily in selenium oxybromide with chemical change.

Separation of the Hydrocarbon Series by Selenium Oxybromide.—It is possible to separate the various hydrocarbon series from one another. Benzene and toluene dissolve in selenium oxybromide and can be separated from such hydrocarbons as heptane which is immiscible with selenium oxybromide and is immiscible with a solution of the benzene or toluene in the oxybromide. The lighter heptane floats. Such nnsaturated hydrocarbons as amylene can also be separated from heptane by selenium oxybromide. Naphthalene and heptane are readily separated by this reagent.

Carbohydrates and Proteins. — Selenium oxybromide when just melted dissolves with ease such proteins as hair, silk, leather, gliadin from wheat, zein from corn, glutenin from wheat, elastin, gelatin, blood albumen and egg albumen.

Its action on cellulose is not appreciable. The melted substance can be filtered through filter paper, as has been frequently done in this laboratory.

Vegetable and Fish Oils.—The action of selenium oxybromide toward the vegetable and fish oils is similar to the behaviour of sulfur monochloride or selenium oxychloride. With oils having a high iodine number the action is vigorous, while with the oils which are of a more saturated character the action is more moderate. The oils are changed into a rubber-like mass which contains selenium and bromine. The oils examined were raw and boiled linseed, china wood, soy bean, corn, cotton, sesame, peanut, castor, olive, palm, coconut, menhaden, cod liver, whale, sperm, lard and neat's foot oil.

The "Insoluble" Phenolic condensation products, Redmanol and Bakelite, dissolve readily in melted selenium oxybromide. The reaction is accelerated by heat. The substances are changed chemically.

Gums, resins, dried paints, lacquers, baked organic enamels, glues, and insoluble casein glues dissolve readily in melted selenium oxybromide. Saturated substances such as ozocerite form 2-component systems in which the lighter melted substance floats on the heavier selenium oxybromide layer.

Coals and Carbons. —When melted, selenium oxybromide is brought into contact with coals of the bituminous variety,

reaction takes place with the resinic and bituminous parts of the coal, solution of a part of the coal is effected, and at the same time an insoluble carbonaceous residue is left behind.

Anthracite coal containing no volatile combustible matter is unaffected, as are thoroughly ignited coke and graphite.

Amorphous forms of carbon containing hydrocarbons lose their hydrocarbon content when treated with selenium oxybromide. Thus, ordinary lampblack yields a black extract with melted selenium oxybromide, leaving behind carbon.

Activation of Charcoal by selenium oxybromide can be accomplished readily. "Retorted" nut carbon when treated with melted selenium oxybromide loses hydrocarbons and actually effervesces in the cold from the heating effect produced in the chemical reaction.

Similarly, a solution of selenium oxybromide in carbon tetrachloride or benzol, extracts hydrocarbons from "unactivated" nut charcoal, leaving behind activated carbon which does not react with selenium oxybromide.

Acknowledgment is hereby made of the valuable aid rendered in various parts of this work by my research assistant, C. W. Muehlberger.

SUMMARY.

Selenium oxybromide is a reddish-yellow solid melting at 41.5-41.7°.

It can readily be prepared by any reaction in which pure selenium dioxide and tetrabromide are brought in contact.

When heated, selenium oxybromide slowly begins to dissociate just above its melting point, while at higher temperatures the dissociation is so great that it is impracticable to use distillation, even under reduced pressure, as a means of purification.

Its chemical properties are similar to those of the oxychloride.

In liquid form, above 42°, it is a powerful solvent, deporting itself in general as an oxidizing and brominating agent.

Madison, Wisconsin.

THE PREPARATION OF FRUCTOSE.

T. SWANN HARDING.

As inulin gives only fructose on hydrolysis, it is an ideal starting point for the preparation of this sugar, but owing to its comparative scarcity, sucrose has been used in this research. 2,000 gm. of sucrose are dissolved in 6,000 cc. distilled water, and the optical activity of the solution measured. The solution is next inverted by means of invertase. Complete inversion is brought about when the Ventzke reading is one-third of the original optical activity but negative instead of positive. The liquid is then treated with a little decolorising carbon, filtered and evaporated to a thick syrup under vacuum. This is now mixed with twice its volume of hot glacial acetic acid, cooled and "seeded" with glucose. After 3-4 days the glucose crystals are filtered off, washed with glacial acetic acid and dried *in vacuo*.

The filtrate containing the fructose is diluted with water and concentrated *in vacuo* and repeatedly so treated to remove the acetic acid. When very syrupy an equal volume of hot glacial acetic acid is added, the liquid cooled, and "seeded" with fructose. After 2-3 days, the fructose crystals are filtered, washed with glacial acetic acid and dried in a vacuum. The yield is 23 to 28 per cent. of the weight of sucrose taken. The sugar is recrystallised from hot alcohol and when decolorised and twice recrystallised the fructose will have a specific rotation of [α] -92°. — (*Jour. Amer. Chem. Soc.*, 1922, p. 1765.)

YIELD OF GLUCOSE FROM COTTON CELLULOSE.

J. C. IRVINE AND E. L. HIRST.

The cotton cellulose used contained 6.7 per cent. moisture, 0.14 per cent. mineral ash, 0.07 per cent. oil, 2.47 per cent. soluble in 3 per cent. caustic soda, and had a copper reduction figure of 0.37 per cent. From this, cellulose triacetate was prepared by soaking in glacial acetic acid and passing through it a stream of dry chlorine gas for 30 seconds. After standing, more acetic acid was added, and SO_2 passed through the liquid, and the whole allowed to stand for an hour, and the temperature raised to 65°. The clear solution was cooled, chloroform added, and then an excess of water. The chloroform was next evaporated off, when the acetate separated out and was washed free from acid and dried. The composition was found to ague with C H $O_5(CH_3.CO)_3$. This triacetate

was next hydrolysed and condensed with methyl alcohol in one operation by heating it with methpl alcohol and a very little hydrogen chloride in a sealed tube at 125° C. The resulting methyl glucosides were recovered by neutralising, decolorising and evaporating the liquid under reduced pressure and crystallising from a little hot alcohol. The crystals had M.P. 125-150° C., and were an equilibrium mixture of α and β methylglucoside. The scheme of the work is to convert the cellulose into cellulose triacetate (99.5 per cent. yield), and to transform this into the methyl glucosides corresponding to a yield of 95.1 per cent. of glucose. It is considered that cotton cellulose consists entirely of glucose residues.—(*J.C.S.*, 1922, *Trans.*, *p.* 1585.)

THE MULTI-BROMO-NAPHTHALENES OF FROM FOUR TO SIX ATOMS OF BROMINE, AND OTHER HALOGEN-COMPOUNDS OF THE SAME GROUP.

By John Missenden.

With regard to the compounds of this heading, most of which form themselves nnder isomeric groups, it will be especially noted that they are entirely composed of eighteen atoms of matter, ten of which are always carbon, the other eight being hydrogen and one or two of the halogens. The grading of the compounds, therefore, depends upon the displacement of hydrogen as the numerical value of the halogens increases.

Of the compounds containing but four atoms of bromine, *α-tetrabromonaphthalene* (1:4:3′:2′) is foremost, the other being the β-compound. α-Tetrabromonaphthalene takes the form of elongated pyramoids (which, on becoming anhydrous, assume a flat prismatic shape) which melt at 191.3° C. It may be prepared by treating β-dibromonaphthalene-tetrabromide, $C_{10}H_6Br_2Br_4$, with sodium ethylate dissolved in alcohol, and will produce dibromophthalide and tetrabromo-α-naphthoquinone if subjected to a solution of chromium trioxide in acetic acid. *β-Tetrabromonaphthalene* possesses similar properties to the α-compound, except that it is readily soluble in ether, whereas the other is scarcely soluble. Both are soluble in alcohol, but insoluble in water. The β-compound fuses at 127° C., and is produced, together with its isomer,[1] from α-dibromonaphthalene-tetrabromide.

The pentabromo-compound, like the hexbromo-compound, has only one known form. Its formula is $C_{10}H_3Br_5$; and it has a granular appearance, is colourless, and is insoluble in alcohol. It may be produced by mixing α-tetrabromonaphthalene with bromine and heating the mixture to 165.3° C. *Hexbromonaphthalene*, $C_{10}H_2Br_6$, has a pyramoid form which, on becoming anhydrous at 232.8°—233.3° C. is transformed into flat prismoids. It is slightly soluble in benzene[2] and chloroform, and totally insoluble in ether, alcohol and water. It may be prepared by mixing four parts of naphthalene with three parts of bromine and one of iodine, and heating the whole to 310° C.

Many compounds of the bromo-chloro-order are known, most of which were discovered by Laurent, but only the simple bromochloronaphthalene and its three isomeric forms will come within the scope of this paper. *Bromochloronaphthalene*, $C_{10}H_6BrCl$, has the α-form, β-form, and γ-form. The α-compound (Cl:Br=4′:1) is a pyramoid-crystalline substance which fuses at 116.7° C.[3] It is formed by submitting α-bromonaphthalene-sulphochloride to the action of phosphorus pentachloride. The β-compound crystallises in flat prismatic shapes, and may be prepared, together with the γ-compound, by either treating α-chloronaphthalene with bromine or treating α-bromonaphthalene with chlorine. On oxidation, chlorophthalic acid appears. Both the α- and β-compound are almost insoluble in alcohol. The γ-compound is anhydrous and is similar in form to the β-compound. It fuses at 64.3° C., boils at 308° C., and is soluble in alcohol. It yields bromochlorophthalide on oxidation.

1 *Roscoe and Schorlemmer.*

2 *Gessner; Ber. Deutche. Chem. Ges.;* 9 1510.

3 *According to Cleve* (*Bull. Soc. Chim.;* 26, 540) *the figure is* 115° *C., both results being at N.T.P.*

GENERAL NOTES.

THE SIR JOHN CASS TECHNICAL INSTITUTE, JEWRY STREET, ALDGATE, E.C.3.

The new session of the Sir John Cass Technical Institute, Aldgate, E.C.3, will commence on Monday, September 25th. Students will be enrolled during the previous week, commencing Monday, September 18th, between 6.30 and 8.30 p.m.

The courses of instruction at the Institute meet the requirements of those engaged in chemical, metallurgical, electrical, petroleum, and the fermentation industries. Full facilities are provided in the well-equipped laboratories of the Institute for special investigations and research. The instruction in experimental science also provides systematic courses for the examinations of London University and of the Institutes of Physics and Chemistry.

Special courses of higher technological instruction form a distinctive feature of the work of the Institute, and for the forthcoming session these include Brewing, Malting, Micro-Biology, Petroleum Technology, Colloids, Alternating Currents and Electrical Oscillations, Mathematical Statistics, Metallography and Pyrometry, Heat Treatment and Mechanical Testing of Metals and Alloys, and Foundry Practice.

RAMSAY MEMORIAL TABLET IN WESTMINSTER ABBEY.

H.R.H. the Prince of Wales, who is Patron of the Ramsay Memorial Fund, has consented to unveil on Friday, November 3rd, at 12 noon, the memorial tablet of the late Professor Sir William Ramsay, which is being placed in Westminster Abbey.

The tablet has been executed by Mr. Charles L. Hartwell, A.R.A. It was exhibited at the Royal Academy this summer.

Invitations will be sent out in October. Any communications with respect to the unveiling should be addressed to the Organising Secretary of the Ramsay Memorial Fund, Dr. Walter W. Seton, at University College, London, Gower Street, W.C.1.

THE PASTEUR COMMEMORATION FUND

We are informed by Mr. A. Chaston Chapman, hon treasurer in this country for the Pasteur Commemoration Fund, that the sum of £848 11s. 6d. has been subscribed, and that this amount has been forwarded to Monsieur Héring, the General Treasurer, with an intimation that should the amount prove more than the French Committee desire to expend upon the monument, the excess should be devoted to some other form of permanent memorial of Pasteur in the University of Strasbourg.

THE USE OF BASIC SLAG AS A FERTILISER.

Bessemer basic slag, in suitable cases, has effected remarkable improvement in grassland, whether pasture or meadow. It produces its most striking results on heavy land covered with poor herbage containing large quantities of "bent grass," which goes brown in autumn, giving a very parched appearance to the field. The best known instance is that of Cockle Park, where grazing capable of carrying about 1¼ sheep per acre and producing only about 25 lb. of live weight increase per acre each season has been so improved that it now carries about 3½ sheep per acre and produces about 100 lb. live weight increase.

The improvement is effected through the agency of the wild white clover, which begins to develop soon after the slag is applied. It is therefore essential that the conditions should favour this plant, and for this reason it is wise to adopt a bold policy and give a substantial dressing of slag at the outset. Where drainage is necessary this must receive attention, but there are instances where the wetness of the grass is due not so much to faulty natural drainage as to a mat of moss or decaying vegetation which impedes the soaking away of the water. In such cases the unslagged land may remain wet while on the slagged land the mat disappears and the water gets away naturally.

It is sometimes supposed that slag acts well only if there is heavy rainfall, but this is shown not to be the case by the Essex experiments conducted by Prof. G. Scott Robertson. Although the rainfall is not particularly high, slag has improved the yield of hay, raising it from 10 cwt. per acre on the unmanured to 20 cwt. per acre on slagged land in one of the poorest fields, and from 30 cwt. on the unmanured to 40 cwt. per acre on the slagged land in one of the best fields. Here also the chief im-

provement is in the type of herbage: the clover increases considerably, and the land is more completely covered with vegetation, with the result that its temperature is lower in summer, there is less wastage of water by evaporation, and in consequence the crop has a larger available supply of water.

CANTHARIDIN BEETLES.

*In the November, 1920, issue of the Journal** there was published an article on mylabris beetles, a large group of which are generally known as "blister beetles," and which have a comercial value. These beetles are dried and reduced to a powder, from which is obtained a crystalline substance known as cantharidin. This is occasionally used internally in minute doses as a stimulant and diuretic, but its principal use is in solutions, tinctures, plasters, etc., where a strong irritant is required. The *Journal* article (which is illustrated) deals with the life-history of these beetles, their food habits, uses, methods of killing, collection and preparation, etc.

An effort is now being made by the Department of Mines and Industries (Industries Division) to establish a local industry in connection with *Mylabris oculata* beetles ("Spanish fly" or "Boontje Keever"), which are a source of cantharidin and are found in many parts of the Union. Technical reports obtained from London on a sample of South African mylabris beetles indicate that there is a likelihood of finding a market in the United Kingdom for them, but before anything more definite can be said on this point it will be necessary to forward a commercial sample to London. For this purpose, Mr. E. D. Punter, P.O. Lead Mine, Koster, Transvaal, is acting in co-operation with the Industries Division, and will be prepared to receive collections of mylabris beetles from anyone in a position to supply, and prepare them for shipment to England. Persons willing to assist in this matter should communicate direct with Mr. Punter, who will give them full particulars of the proper method of killing and packing the insects. He will also make payments for the beetles at the rate of 2s. 6d. per pound.

* *Journal of the Department of Agriculture, Union of South Africa.*

New Patents.

This list is specially compiled for *Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

221721—Alexandra, H. M.—Separating liquids of different specific gravity. August 15.
22625—Bengough, G. D.—Method of preserving aluminium and its alloys from corrosion. August 19.
22045 Clayton, W. C.—Manufacture of hydrogen peroxide. August 14.
22347—Douglas, R. P.—Manufacture of sulphate of ammonia. August 17.
22243—Mond, A. L.—Chloridizing roasting of ores. August 15.
22455—Sim, D. J.—Manufacture of lead carbonate. August 17.

Specifications Published This Week.

183897—Haddan, P.—Process of converting organic acids into esters.
171391—Stockholm Superfosat Fabrikens Aktiebolag.—Method of manufacturing acetone from acetic acid.
184129—Buymberke, J.—Dehydration of alcohol.

Abstract Published This Week.

Extracting Glue.—Patent No. 181865.—A new process for extracting glue from raw materials containing gelatine and glue has been developed by Messrs. Plauson's (Patent Co.), Ltd., of 17, Waterloo Place, Pall Mall, London.

The material is subjected to high speed mechanical disintegration with water and preferably a small quantity of a substance rich in oxygen, in a mill, having a peripheral speed of not less than 1,000 metres per minute, such as is described in Specifications 176002, 176003, and 179124. The extraction may be carried out under a small steam pressure. The glue solutions thus obtained are then treated, preferably in a mill as described above, with a liquid immiscible with water, such as a chlorinated hydrocarbon, a paraffin, or other hydrocarbon, or mixtures such as ether with acetone or alcohol. The emulsification may be assisted by addition of small quantities of a water-soluble organic liquid. The emulsion obtained is either allowed to separate into two layers or the separation is accelerated by use of pressure, by addition of small quantities of a strong acid or salt thereof, by centrifuging or by osmotic means. One layer consists of a solution of fats, etc., in the organic solvent, and the other of a solution of glue in water. The second treatment with a solvent may be repeated if necessary. In examples of finely ground fish waste, waste hide or leather, and bones are treated with water and a small quantity of potassium permanganate or of sulphur dioxide in a colloid mill, and the solid impurities are removed by settling centrifugalization, or filtration. Ether, benzene, and trichlorethylene are mentioned as solvents for the fats, both the solvents and the fats and protein being recoverable. The glue is obtained by ordinary boiling and drying.

Messrs. Rayner & Co. will obtain printed copies of the published specifications, and forward on post free for the official price of 1s. each.

THE CHEMICAL NEWS,

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THE INSTITUTE OF METALS.

ANNUAL MEETING, SWANSEA, SEPTEMBER 20TH, 1922.

Summary of SIXTH REPORT TO THE CORROSION RESEARCH COMMITTEE OF THE INSTITUTE OF METALS on "THE NATURE OF CORROSIVE ACTION, AND THE FUNCTION OF COLLOIDS IN CORROSION," by GUY D. BENGOUGH, M.A., D.Sc., *and* J. M. STUART, M.A.

This Report attempts to present a general discussion of corrosion phenomena, based on the study of several different metals, and to examine how far the electrochemical theory of corrosion usually called the electrolytic theory) can account for the observed phenomena. The difficulties encountered by this theory are indicated, and it is shown that it gives a satisfactory account of the facts only under certain conditions, while many facts can only be explained by recognising the important part played by colloids in *corrosion*. A theory of the mechanism of colloid action is put forward, and some experimental results are reviewed in the light of this theory.

The Report commences by defining the terms corrosion, chemical exfoliation, erosion, and scale, which are used somewhat loosely by some writers. Corrosion is defined in its widest sense as the oxidation of a substance. It is then pointed out that such oxidation may be produced by chemical or *electro-chemical means, and these* two types of reaction are defined. Chemical reactions may occur when the reacting bodies are in contact, electro-chemical reactions when the reacting bodies are spatially separated. In the latter case the reacting substances must be capable of ionization, and a portion of the energy of the system appears as electrical energy. Two cases of corrosion are considered, both of which can be carried out chemically or *electro-chemically*. *Pure electro-chemical* action may in certain cases be relatively unimportant. Thus the cathode of a cell of high voltage may be more rapidly attacked than the anode, while an anode at a high voltage tending to force it into solution may be very little corroded owing to scale formation.

Further facts which are difficult to explain on a purely electro-chemical theory are the following:

1. Certain depolarizers do not increase corrosion, but actually inhibit it.
2. The conductivity of electrolytes is not directly connected with the amount of corrosion.
3. Lambert's pure iron (probably the purest metal ever produced) was found to be readily attacked by sodium chloride solution and dilute acids.
4. According to the electro-chemical theory, the presence of ions of the corroding metal should depress the corrosion of most of the common metals. There are, however, numerous exceptions, and in some cases the presence of such ions actually increases corrosion.

The order of corrodibility of metals in distilled water, certain salt solutions, and non-electrolytes, is different from their order in the electro-chemical list, which suggests that there are factors interfering with the electro-chemical action. Such a factor is scale formation, and a main factor in determining the amount of corrosion by *water and salt solutions is the* nature and distribution of the products of corrosion. This may be far more important than any hypothetical distribution of cathodes and anodes in the metal.

The effects of strain and impurity in the metal are considered on the electrochemical view to be of fundamental importance, and Lambert's pure iron and lead were prepared with a view to eliminating both these factors. Neither metal was *incorrodible in certain conditions*. However, potential differences between strained and unstrained portions of the same metal are usually very small, and unstrained (annealed) metal may corrode more rapidly than strained metal. In fact, the effect of strain is a minor and ephemeral factor in corrosion in neutral solutions.

As regards the effect of impurities on the corrosion of metals, a trace of impurity appears to assist local corrosion, but the amount of corrosion *is not proportional to* the amount of impurity. Even the presence of graphite does not appreciably stimulate the rate of corrosion of iron. The effect of a trace of impurity is probably a trigger action.

Local action at metallic surfaces may be produced in a variety of ways at any selected points by modifying the conditions *external to the surfaces, and is not* mainly determined by the presence of anodic areas on the metal. Minute pores in a metal may, however, give rise to local action, as has been shown by Seligman and Williams.

On the electro-chemical theory the action of oxygen is that of a depolarizer. It can be shown, however, that atmospheric oxygen has very little depolarizing power at ordinary temperatures. The main function of oxygen in corrosion is to oxidize directly the metal, and also in some cases the products of corrosion.

The effect of over-voltage on corrosion phenomena is briefly considered.

Two chief types of corrosion are distinguished: (1) The general type, usually characteristic of acid corrosion; (2) the local type, usually characteristic of corrosion in water and salt solutions. The second type is generally characterised by the formation of an adherent scale on the metal, and this scale may contain colloid.

A theory is developed regarding the part played by colloids in corrosion, and this theory may be briefly outlined as follows:

A metal immersed in water sends positively charged metal ions into the liquid, and becomes itself negatively charged. In the case of ordinary commercial metals, the metal also becomes superficially oxidized if dissolved oxygen is present. The hydroxide produced by this oxidation can take up the ions given off by the metal, and the hydroxide thereby passes into the state of a positively charged colloid. Some of this colloid will diffuse away, permitting further reaction between the oxygen and the metal surface, and thereby reforming the hydroxide film over the latter. Oxidation is then stopped till this hydroxide can pass into the colloidal state by acquiring positively charged metal ions. This, in general, does not take place till the colloid initially formed has diffused into the presence of electrolyte, when it is precipitated by the anion of the dissolved salt, the cation neutralising the charge on the metal corresponding to that on the colloid. This allows the metal to send more ions into solution, and the uncharged hydroxide thereby acquires a charge. If the colloid so produced can diffuse away, the process can continue and corrosion develop.

For steady corrosion, therefore, the colloid must be produced under conditions which allow it to diffuse some distance *from the metal before precipitation. If it* precipitates directly on the corroding surface, it will, in general, adhere to the latter and stop corrosion. In the case of a corrosion pit, the first condition is fulfilled, since no precipitation occurs inside the pit. It is only when the colloid diffuses through an aperture (generally very small), in the gel-deposits at the mouth of the pit, that it meets electrolyte and is then precipitated. Such precipitation merely thickens the external gel-deposits. These gel-deposits adhere directly to and protect the metal surrounding the pit, and thereby emphasise the local nature of the corrosion.

Summary of Note on "THE EFFECT OF SUPERHEATED STEAM ON NON-FERROUS METALS USED IN LOCOMOTIVES," by Sir Henry Fowler, K.B.E., *presented at the Annual Autumn Meeting of the Institute of Metals, held in Swansea, on Wednesday, 20th September,* 1922.

Superheated steam is now very generally used on locomotives, the steam usually leaving the superheater at a temperature of 340° C. Not all the parts mentioned are subjected to this continuously, as the steam expands, and in so doing falls in temperature. The practice referred to is that adopted on the Midland Railway.

Piston Tail Rod Bushes.—These were originally made of:—

	per cent.	
Copper	87	
Tin	9	
Zinc	2	
Lead	2	called M.R.A.
	—	1 alloy.

but this was found to break in service. The cast iron which replaced it was found to score the rods, but a phosphor bronze of the following composition has been found to be satisfactory:—

	per cent.
Copper	88
Tin	11
Phosphorus	1

Piston Rod Packing.—McNamee rings of the following composition:—

	per cent.
Copper	75.5
Tin	8.5
Zinc	0.33
Phosphorus	trace
Nickel	0.5
Lead	15.0

are used satisfactorily. These rings are to prevent the steam coming into contact with the white metal packing rings, of the following composition:—

	per cent.
Lead	70
Antimony	30

Recently when the temperature of the steam leaving the superheater has been as high as 425° C. trouble has been experienced with the packing rings fusing. The full heat is only on these parts intermittently.

Piston Valve Fittings and Cylinder Relief Valves.—These have been made of alloy M.R.A. 1 and have acted satisfactorily.

By-Pass Valves.—These are subjected to shock; and good quality cast iron, gunmetal of M.R.A. 1 alloy, and phosphor bronze, as tried in tail rod bushes, were found unsatisfactory. A complex nickel-brass, however, gave good service, but in view of tse expense were replaced by malleable iron or steel castings

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Summary of Paper on "WHITE METALS," by A. H. MUNDLEY, C. C. BISSETT, B.A., B.Sc., B.MET., *and* J. CARTLAND, M.C., M.Sc., *presented at the Annual Autumn Meeting of the Institute of Metals, held in Swansea, on Wednesday, September 20th,* 1922.

The authors review the manufacture and use of white metal for industrial purposes.

The composition, mechanical and physical properties of the chief alloys are given. Their constitution and microstructure are dealt with only so far as the uses and manufacture are concerned.

The chief representative grades of anti-friction or bearing metal are described, the application of appropriate alloys for particular purposes being indicated.

The effect of overheating or injudicious handling is described. Considerable attention is given to the preparation and properties of the various classes of printing alloys. The characteristics of each grade being given, the necessities of the printer and method of employment so far as these alloys are concerned are discussed.

Brief references are made to die casting alloys, metals for chemical works' castings, solders, etc.

The paper is illustrated by photo-micrographs and prints.

Summary of Paper on "GRAIN-SIZE AND DIFFUSION," by PROFESSOR J. H. ANDREW, D.Sc., *and* ROBERT HIGGINS, *presented at the Annual Autumn Meeting of the Institute of Metals, held in Swansea, on Wednesday, September 20th,* 1922.

Experiments have been conducted which show the relation between grain growth and diffusion. Diffusion at high temperatures may take place simultaneously with grain-growth, whilst at low temperatures diffusion promotes a breakdown in the grain-size. These results have been applied to the annealing treatment of commercial castings. A suggestion has been advanced to explain the atomic arrangement existing at the grain boundary. It has been assumed that in the interior of the crystalline grains the system of closest packing holds, whilst at the boundaries the atoms in the separate grains touch only at one part of the circumference. This explains the decrease in specific gravity with an increase in the number of grains, for in such an arrangement certain free spaces must occur. Plastic deformation, by shifting the atoms in certain grains from their position of equilibrium, will cause these atoms to rearrange themselves when heated to a sufficiently high temperature; this re-arrangement will be so brought about that the stressed atoms will fall in with, row for row, the unstrained atoms of the adjacent crystal, thereby effecting a gradual migration of the grain boundary. Such a re-arrangement may proceed from every side of a crystalline unit, resulting in one grain being divided up and being absorbed by others. The final bounding surface will result when a state consistent with that suggested for the boundary configuration finally results. A suggestion based upon the Langmuir idea of valency has been given to explain the migration of a separating phase to the grain boundary.

Summary of a REPORT TO THE ALUMINIUM CORROSION RESEARCH SUB-COMMITTEE OF THE CORROSION RESEARCH COMMITTEE OF THE INSTITUTE OF METALS on "EXPERIMENTS ON THE OXIDE METHOD OF DETERMINING ALUMINIUM," by J. E. Clennell, B.Sc., *presented at the Annual Autumn Meeting of the Institute of Metals, held in Swansea, on Thursday, September 21st,* 1922.

The object of the investigation described in this Report was to find a direct method of determining aluminium in presence of iron and other impurities. The phosphate method was rejected, as it had been found that the precipitates obtained showed varying proportions of alumina and phosphoric acid. The ammonia method of precipitating aluminium as hydroxide was likewise rejected owing to the difficulties of filtering and washing the precipitate and obtaining it free from impurities.

Experiments were made on the methods described by previous investigators, in which aluminium is precipitated as hydroxide by alkali nitrites, by phanylhydrazine, and by a mixture of iodide and iodate of potassium, but more satisfactory results were obtained by precipitation with alkali thiosulphates.

It was found in nearly all cases that the weight of precipitate exceeded the theoretical amount calculated from the aluminium known to be present. This excess was traced to the presence of small quantities of absorbed substances, notably salts of iron and sulphates, probably of aluminium, which could not be removed by prolonged washing. Substitution of ammonium thiosulphate for the usually employed sodium salt did not reduce the excess.

A method was finally evolved whereby iron was practically eliminated and other impurities reduced to a minimum. This consists in passing sulphur dioxide through the slightly ammoniacal solution, precipitating in dilute, faintly acid, boiling solution with sodium thiosulphate with addition of dilute acetic acid, washing by decantation with hot 1 per cent. ammonium chloride, filtering and washing with hot water. Iron, zinc, manganese and magnesium in ordinary amounts do not interfere, but when the first two are present in large quantity a double precipitation is necessary. The method was successfully applied in experimental work carried out for the Corrosion Research Committee on the oxidation of aluminium amalgam.

Summary of Paper on "THE CONSTITUTION AND AGE-HARDENING OF ALLOYS OF ALUMINIUM WITH COPPER, MAGNESIUM, AND SILICON IN THE SOLID STATE," by Marie L. V. Gayler, M.Sc., *presented at the Annual Autumn Meeting of the Institute of Metals, held in Swansea, on Thursday, September 21st,* 1922.

Constitution of the Alloys.—The quaternary system of alloys containing aluminium, copper, magneisum and silicon has been regarded as the ternary system aluminium-copper-magnesium silicide, since magnesium and silicon were added in the proportions of the compound magnesium silicide, which is very stable at all temperatures.

The solubilities of copper and magnesium silicide in solid aluminium were determined at 500° C. and 250° C., and microscopic examination showed that the solubility of copper was reduced from 4.5 per cent. to 2 per cent. at 500° C. by the presence of 0.7 per cent. magnesium silicide; while 2 per cent. of copper reduced the solubility of magnesium silicide from 1.2 per cent. to 0.7 per cent. at 500° C. At 250° C. both constituents are turned out of solution when only 0.5 per cent. of each are present.

Age - Hardening. — Brinell hardness measurements were made on alloys in which the percentage content of one constituent was fixed while the other was varied, and which had been quenched from 500° C. and allowed to age-harden at room temperature. The results showed that the age-hardening of these alloys is due to the difference in solubility at high and low temperatures of both copper and magnesium silicide. The maximum amount of age-hardening which it is possible to obtain from such alloys depends on the solubility in aluminium of both constituents in the presence of each other. Further heat treatcent of these age-hardened alloys, at temperatures higher than room temperature, caused a preliminary softening before an increase in hardness; this is probably due to the process hy which both compounds tend to come out of solution.

Derived differential curves of alloys which had been quenched, but not aged, show three critical points; the lowest point takes place at constant temperature, while the temperature of the two upper critical points is lowered with increasing copper content; also the intensity of the uppermost point varies in a marked degree with the copper content. It is suggested that this point is due to the *precipitation of the* copper compound, and the second point to the *recipitation of magnesium silicide.*

(To be continued.)

BRITISH ASSOCIATION.

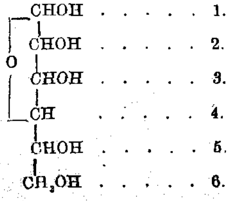
Section B—Chemistry.

PART II.—SOME RESEARCH PROBLEMS IN THE CARBOHYDRATES.

Cellulose, Starch, and Inulin.

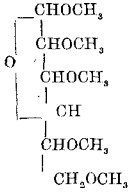
In submitting at this stage an account of the researches upon which my co-workers are at present engaged, I am impressed by the recollection that the first paper on the alkylation of sugars was read to Section B twenty years ago. The communication[1] dealt merely with the progressive methylation of methylglucoside and with the trimethyl and tetramethyl glucoses to which the products give rise. Even at that time it was recognised that the study of methylated sugars opened up a new method of attacking the constitutional problems of the carbohydrates, and the further progress reported to the Association in the following year showed how the process could be applied to determine, in part, the structure of sucrose and maltose[2] The principle underlying these studies may be very briefly stated. Adopting for the moment the accepted formula for glucose it will be seen that a hexose sugar contains five hydroxyl groups:—

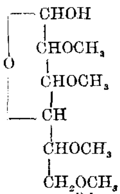
I.



It is to be noted that one of these groups differs from the remaining four in that, although it may be replaced by a methyl group, this is easily removed by acid hydrolysis. On the other hand, when methyl groups are introduced into the remaining positions (numbered 2, 3, 5, and 6 in the formula), they are exceedingly resistent to hydrolytic action. It follows, therefore, *that a fully methylated glucoside (II.)* when heated with acid will be converted *into a tetramethyl glucose (III.).*

II. III.





Similar reactions are impossible with acetyl or benzoyl derivatives of sugars owing to the ease with which the substituting groups are eliminated. In order to illustrate the utility of methylation in determining structure, we may ascribe to any sugar derivative the general formula S—G, where S is a sugar residue and G the group with which it is condensed. Complete methylation may be effected, according to the solubilities involved, by silver oxide and methyl iodide or, alternatively, by *methyl sulphate and alkali.* The compound obtained will yield, on hydrolysis, at least two products, one of which is a methylated sugar. Determination of the number and distribution of the methyl groups in each of the cleavage products gives the structure of the parent compound, as the mode of attachment of the constituents is thereby known.

In the special case where the group G is also a sugar residue the general formula of the complex may be written $S—S_1$. The compound would thus be a disaccharide, and precisely the same structural study can be applied to it. The method is equally applicable to trisaccharides, $S—S_1—S_2$, and finally to polysaccharides $S \ldots\ldots S_n$.

The development of this line of research has demanded the preparation of a large variety of methylated sugars, which play the part of reference compounds in that

the position of the alkyl groups in them is known.

As I wish to deal particularly with the constitutional problems of polysaccharides, I shall make no attempt to summarise the results which have been obtained in the study of the simple sugars, the glucosides, or the disaccharides, but turn at once to the case presented by cellulose.

CELLULOSE.

(With Dr. W. S. Denham and Dr. E. L. Hirst.)

The extensive literature which has grown up on the constitution of cellulose affords little satisfaction to the organic chemist. Despite the complications involved and the many liabilities to error, it seems impossible for workers on cellulose to resist the temptation to ascribe a molecular formula to the compound. The difficulties which stand in the way are too numerous to mention, but the marked stability of cellulose under some conditions and its curious reactivity under others, coupled with its limited solubility and lack of volatility, are outstanding obstacles. As a result, many divergent and even conflicting suggestions have been put forward to represent the polysaccharide structurally, and the views of chemists both within and without the large circle of workers in this field are chaotic. The confusion is increased by the fact that many formulæ for the compound are published in haste to be corrected at leisure, and this unhappy state of affairs was never more pronounced than to-day. I would refer you to an article by Hans Pringsheim[3] in which he classifies the mentality of investigators and puts forward a plea that, if sure progress is to be made, the chemistry of polysaccharides must be pursued slowly step by step. Impetuous and hasty theorising does infinite harm.

The first essential in arriving at a satisfactory formula for cellulose is to ascertain if the aggregate $(C_6H_{10}O_5)_n$ is composed entirely of glucose units, as even this fundamental point has been disputed. To obtain the necessary evidence is not so simple as might appear, and many of the "proofs" which have been offered do not carry conviction to those familiar with the detailed chemistry of the simple sugars. By converting cellulose into the triacetate and thereafter decomposing this product so as to give methylglucoside, we have recently obtained data which leave no doubt that glucose alone is the basis of cellulose.[4] The yield of pure crystalline methylglucoside thus isolated amounts to more than 95 per cent. of the theoretical yield calculated on the basis of the equation:—

$$(C_6H_{10}O_5)_x + x\,H_2O \rightarrow x\,C_6H_{12}O_6.$$

This result applies only to cotton cellulose, and further discussion is therefore restricted to this particular variety. Disregarding structures which are not based upon glucose, the numerous formulæ proposed for cellulose may be approximately divided into two classes:—

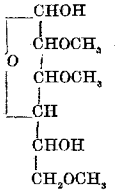
1. Constitutions modelled on that of the glucosides, involving the addition of numerous glucose residues by mutual condensation. According to this view, cellulose consists of large molecules.

2. The unit of cellulose may be regarded as a simple anhydroglucose, $C_6H_{10}O_5$, highly polymerised.

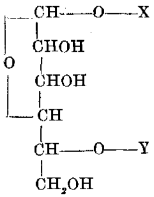
As pointed out, the situation alters almost from day to day, but for the moment a compromise between the above classes is supported, and some authorities prefer to regard cellulose as a simple anhydro-*n*-saccharide (where *n* is a small multiple) polymerised in unknown numbers.

Twelve years ago, after developing the methylation process into a trustworthy method for determining the linkages of sugar complexes, we turned our attention to the constitution of cellulose. The work was undertaken by Dr. W. S. Denham,[5] who, using methyl sulphate and sodium hydroxide as the alkylating reagents, obtained a methylated cellulose in which the methoxyl content was 25 per cent. This value is lower than that required for a dimethyl cellulose (32.6 per cent.), and it followed that, on hydrolysing the product, a mixture of methylated glucoses resulted. From the mixture one definite sugar was isolated, and this Denham[6] proved to be 2, 3, 6-trimethyl glucose (IV.), which was then isolated for the first time.

IV.



Denham's work thus gave the first clear evidence as to the linkage of part of the cellulose molecule, and is one of the most important contributions made to the structural study of complex carbohydrates. Cellulose must contain the unit



but as an incompletely methylated cellulose was employed in the hydrolysis the research left unexplained the nature of the residues X and Y.

The investigation was therefore continued with the object of completing the methylation of cellulose and providing answers to the following questions:—

(*a*) does trimethyl cellulose give, on hydrolysis, a mixture of methylated glucoses in which the average methoxyl content is three groups per C_6 unit,

or alternatively,

(*b*) if trimethyl cellulose gives trimethyl glucose alone, is this sugar a single individual or a mixture of isomerides?

The war interfered with the progress of the work, but other authors have not hesitated to propose formulæ for cellulose based on Denham's results before he had an opportunity to complete his researches and provide answers to the fundamental questions raised above.

In consultation with Dr. Denham we have *repeated his experiments*, and amplified them, so that we are now in a position to propose a structure for the cellulose unit which is based on secure evidence. We *find that the exhaustive methylation* of the polysaccharide, when repeated twenty times, gives a product containing 43.0 per cent. of methoxyl in place of the 45.6 per cent. required for a trimethyl derivative. The carbon and hydrogen values also agree with the formula $(C_6H_7O_2(OMe)_3)_x$, and as the material preserved a fibrous structure there seems little likelihood that profound molecular alteration had taken place. The trimethyl cellulose was heated with a large excess of methyl alcohol containing 1 per cent. of hydrogen chloride for fifty hours at 125-130°. This treatment effected depolymerisation, hydrolysis, and conversion of the scission products into the corresponding methylglucosides. These were distilled in a high vacuum, the total yield obtained being 90 per cent. of the theoretical amount. The following fractions were collected:—

A. Trimethyl methylglucoside.
B. Trimethyl methylglucoside.
C. Trimethyl methylglucoside containing a small proportion of dimethyl methylglucoside.

All the fractions were analysed, and in this way it was shown that the small quantity of dimethyl methylglucoside in fraction C agreed exactly with the deficiency of 2.6 per cent. in the methoxyl content of the trimethyl cellulose used. *No trace of tetramethyl methylglucoside was present.* Moreover, the physical constants of the trimethyl methylglucoside agreed exactly with those recently established for this compound by Irvine and Hirst[7] On hydrolysis of fractions A and B, an 89 per cent. yield of crystalline 2,3,6-trimethyl glucose was obtained. The identity of this product was confirmed by analysis, by mixed melting-point with an authentic specimen, and by the mutarotation in aqueous solution

$$[a]_d + 108° \rightarrow +67.0°.$$

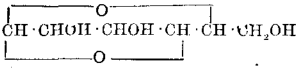
No isomeric trimethyl glucose was present; higher and lower methylated glucoses were absent. We thus reach the conclusion that trimethyl cellulose gives 2,3,6-trimethyl glucose as the only product. The reactions involved in the research are shown below, and, considering the nature

of the operations involved, the yields may be claimed to be quantitative.

Cellulose
↓
Trimethyl cellulose
↓ } Yield 89%
2,3,6,-Trimethyl methylglucoside
↓ } Yield 90%
2,3,6-Trimethyl glucose

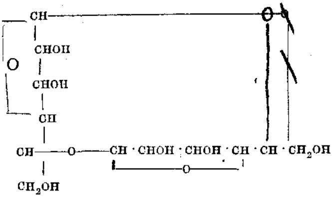
The scheme affords a proof that all the glucose residues in α-cellulose are identical in structure, and the simplest possible formula which will satisfy this condition is that of a 1,5-anhydro-glucose.

VI.



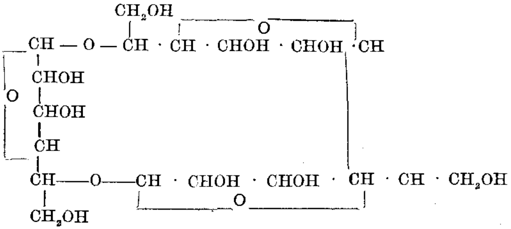
It is necessary, however, to include at least one additional glucose unit to account for the formation of cellobiose,[8] and this is fulfilled by the formula

VII.



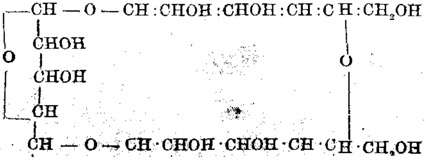
In terms of the above structure, 100 parts of cellulose should give 105.5 parts of cellobiose, and here the difficulty is encountered that the yields of this disaccharide are extremely variable, and rarely exceed 35 per cent. The highest claimed is of the order 50-60 per cent., and in the meantime it is prudent to select a formula for cellulose which will give a result only slightly higher than this figure. We therefore propose the symmetrical tri-1,5-anhydro-glucose (VIII.) for the unit of cellulose, on the ground that this structure would give a 79 per cent. yield of cellobiose as the theoretical maximum.

VIII.



There is, however, an alternative method of coupling the glucose residues, and this gives the structure shown in Formula IX.

IX.

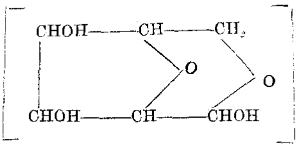


Taking into account the fact that it can yield only one disaccharide, we prefer Formula VIII. *to the above structure.* The essential properties of cellulose, so far as they are displayed in chemical reactions, are accounted for by both formulæ. Further, the structures are not inconsistent with the production of bromomethyl furfuraldehyde9 from cellulose, and indicate that the normal yield of this derivative involves the reaction of one-third of the total unit.

The various formulæ which, in the past, have been *proposed for cellulose have been* summarised by Hibbert.[10] With the *exception of a structure suggested by this* author, and in supporting which he prematurely assumed that only one form of trimethyl glucose could be obtained from cellulose, the structures he tabulates do not in any case agree with the evidence we now produce. Typical examples are quoted:—

Green's formula :—

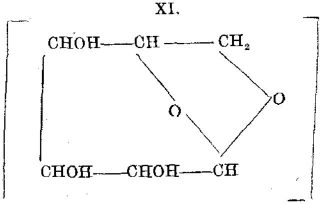
X.



would give a trimethyl cellulose which on hydrolysis would lose one methyl group and be converted into 3,4-dimethyl glucose of the amyleneoxide type.

Vignon's formula[12] :—

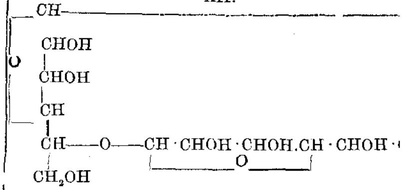
XI.



is equally unsatisfactory in that the final product should then be 2,3,4-trimethyl glucose of the amylene-oxide type.

The formulæ proposed by Tollens,[13] Cross and Bevan,[14] Bartelemy,[15] and Pictet[16] may be deleted for similar reasons. It is also possible to dispose of Karrer's[17] formula, which is that of an anhydro-cellobiose (termed "cellosan")

XII.

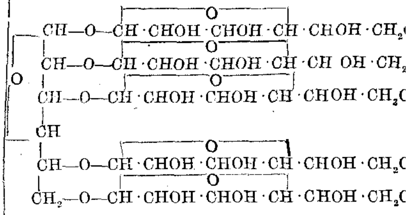


A compound possessing this structure would yield, *on methylation and hydrolysis,*

1 molecule of 2,3,5-trimethyl glucose and 1 molecule of 2,3,6-trimethyl glucose. Our experimental evidence is completely opposed to this view.

An entirely different type of cellulose formula may now be tested. Hess proposes[18] a glucosidic structure which bears a general resemblance to Fischer's constitution for tannins. Space does not permit of these formulæ being given in full, but the general *form will be evident from* the simplest example:—

XIII.



Variations are introduced by lengthening the sugar chains until finally a molecule is obtained with eighteen glucose residues ($C_{108}H_{182}O_{91}$). The feature common to all these glucosidic formulæ is that the hydroxyl groups are not symmetrically distributed in the glucose residues. The simplest structure suggested by Hess would give by our processes five molecules of 2,3,5,6-tetramethyl glucose and one molecule of glucose, while his more elaborate molecules would also result in these com-

pounds together with trimethyl glucose. The reactions of trimethyl cellulose exclude all formulæ of this nature.

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5 *Denham and Woodhouse, J.C.S.*, 1913, 103, 1735; *ibid.* 1914, 105, 2357.
Denham, J.C.S., 1921, 119, 77

6 *Denham and Woodhouse, J.C.S.*, 1917, 111, 244.

7 *Irvine and Hirst, J.C.S.*, 1922, 121, 1213.

8 *Irvine and Soutar, loc. cit.*
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13 *Tollens, Kurzes Handbuch der Kohlenhydrate*, 1914.

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15 *Bartelemy, "Caoutchouc and Gutta Percha,"* 1917, 9274; 9328.

16 *Pictet and Sarasin, Helv. Chim. Acta*, 1918, 1, 187, *and subsequent papers.*

17 *Karrer and Smirnov, Helv. Chim. Acta*, 1921, 5, 187.

18 *Hess, Zeitsch. Elektrochem.*, 1920, 26, *Nr.* 11.

GERMANY'S COAL POSITION.

German industry generally is suffering more and more from the loss of the valuable coal measures alienated to other countries, and intensified by the deliveries required for the Allies. Interesting efforts, as is known, are being made in the country to get greater relative value out of the coal available.

The Capetown correspondent of the *Manchester Guardian Commercial* gives an account of the recently reported new discovery of gold in the West Rand. "If it be true that a new reef has been discovered," he says, "and that it will pay to work, there will be no lack of capital to promote new propositions. It is a little early to speak definitely in regard to this prospect. Men are being attracted to the new fields, and prospecting is in progress. Those who are supposed to know are sanguine, and the hope is held out that the mining industry will shortly assume increased attention. Apart from this, however, South Africa is moving forward as a producing country. The fruit trade is increasing by leaps and bounds, and its future is assured. The export trade is, in point of fact, overtaking the capacity of the shipping companies and the port facilities. Greater cold-storage accommodation on board the fast steamers is demanded, and the Government is being pressed to increase the storage accommodation of the Capetown docks. Indeed, it is just a question whether in the near future it will not be necessary to place on the service vessels specially constructed to deal with the fruit trade. The output of citrus fruit is increasing yearly. The crops in Rhodesia, Transvaal, Orange Free State, and, of course, the Cape, are improving in quantity and quality, and apparently the demand for high-grade oranges overseas is unlimited. Other promising indications are the increasing exports of bacon, dairy produce, and meat. In short, the hope is held out that as the mining areas depreciate the country will be able to derive ample compensation from developments in its farming enterprises."

CEVADINE.

BY A. K. MACBETH AND R. ROBINSON.

Cevadine, $C_{32}H_{49}O_9N$ is one of the alkaloids present in the seeds of *Veratrum Sabadilla*, which on hydrolysis gives cevine

$C_{32}H_{49}O_9N$ and tiglic acid (*Wright and Luff*, *Trans.*, 1878, p. 338.) The present authors confirm this impirical formula on a sample of cevadine recrystallised from alcohol and dried *in vacuo*. It is dextrorotatory, $[\alpha]^{17°}_{D}$ in alcohol being +12.5°, in pyridine +6.38°, and in acetone +1.25°. O-nitrobenzoylcevadine was prepared by adding o-nitrobenzoyl chloride to an alkaline solution of cevadine; on recrystallisation pale yellow crystals M.P. 220°-236° C. (decomp.) were obtained. On hydrolysis with alcoholic potash, potassium cevine separated out in crystals from which cevine was obtained by decomposing with CO_2. Recrystallisation from aqueous alcohol gave $C_{27}H_{43}O_8$ N. $5H_2O$. The compound was lævorotatory $[\alpha]^{17°}_{D}$ in alcohol being -17.52°, in methyl alcohol -15.36°, and in acetone -30.8°. On methylation, an amorphous methyoxy compound $C_{27}H_{42}O_8N$. (O Me) was formed.

Di-(o-nitrobenzoyl) cevine was prepared by the Schotten Baumann method. It is a pale yellow powder, M.P. 175° and lævorotatory, $[\alpha]^{17°}_{D}$ = -54.7 in alcohol. On distillation with soda lime in a stream of hydrogen a substance responding to the reactions for l-coniine was isolated.—(*J.C.S.*, *Trans.*, 1922, p. 1571.)

BRITISH ASSOCIATION.

Fuel Economy.

Fifth Report of Committee (Professor W. A. Bone,* *Chairman;* Mr. H. James Yates,* *Vice-Chairman;* Mr. Robert Mond,* *Secretary;* Mr. Robert Armitage, M.P., Mr. A. H. Barker, Professor P. P. Bedson, Dr. W. S. Boulton, Professor W. E. Dalby, Mr. E. V. Evans,* Dr. W. Galloway,* Mr. J. E. Hackford, Sir Robert Hadfield, Bart.,* Dr. H. S. Hele-Shaw,* Mr. D. H. Helps, Dr. G. Hickling, Mr. A. Hutchinson,* Mr. S. R. Illingworth, Principal G. Knox, Professor Henry Louis,* Mr. H. M. Morgans, Mr. E. Myers, Dr. J. S. Owens, Mr. W. H. Patchell,* Mr. H. Stafford Rayner, Mr. L. L. Robinson, Mr. A. T. Smith, Dr. J. E. Stead, Mr. C. E. Stromeyer, Mr. W. C. P. Tapper, Mr. W. Thorneycroft, Professor W. W. Watts,* and Mr. C. H. Wordingham*) *appointed for the Investigation of Fuel Economy, the Utilisation of Coal, and Smoke Prevention.*

* Denotes a member of the Executive Committee.

I.—The Coal Situation.

Since the Committee last reported, the fuel situation in this country has been dominated by the effects of the coal crisis of 1921. The output of coal from mines in Great Britain during the year ending December 31, 1921, fell to 163 million tons, of which 24.66 million tons were exported, and a further 11 million tons (including about 133,000 tons of manufactured fuel) were consumed by steamers engaged in the foreign trade. There were also exported 443,565 tons of gas coke, 850,074 tons of manufactured fuel, and 292,648 tons of other sorts of coal fuel. Owing to the coal stoppage, there were imported into the country during the year (but chiefly during the three months, April—July inclusive) altogether some 3.433 million tons of coal, and 136,424 tons of coke and manufactured fuel.

In its last Report, the Committee drew attention to the effects of the then high coal prices upon the prospects of the iron and steel industry in this country; and as this particular industry reflects almost better than any other the effects of coal prices upon production, the following observations may appropriately be made upon the present situation.

The crisis of last year in the coal trade was the final cause of the severe depression which in the pig-iron and steel trade had gradually been setting in since the miners' strike in the autumn of 1920. The latter came upon the trade following a period of high prices and abnormally high demand, and precipitated a complete cessation of business and great difficulty in obtaining new orders. This was further accentuated by the general post-war economic conditions in the world's markets. At the same time on the Continent there was a cheapening in the cost of production, together with a serious drop in exchange values and pressure of the banks on the Belgian and French works to realise stocks, and in consequence the foreigner was enabled to deliver pig-iron into Great Britain at a lower price than it could be made at home. Hence, whilst the pig-iron sales had been

maintained fairly well up to the end of 1920, the first months of 1921 saw the importation of both pig-iron and steel into Great Britain on a large scale, foreign pig-iron being delivered into Scotland about thirty shillings per ton below the cost of manufacture in Great Britain. The coal crisis of the following months completed the disaster.

The combined effect of these various causes is well shown by contrasting the production of pig-iron and steel in the United Kingdom in the years 1920 and 1921 respectively. During the year 1920 the output of pig iron was 8,034,700 tons, and of steel 9,067,300 tons; in 1921 these figures had fallen to 2,611,400 and 3,625,800 tons respectively. The following analysis of the corresponding productions for each quarter of 1921 is very instructive in this connection:—

	Pig-iron Tons.	Steel Tons.
January-March	1,491,700	1,336,000
April-June	74,700	79,000
July-September	262,700	980,600
October December ..	782,300	1,230,200
	2,611,400	3,625,800

On operations being resumed at the mines, production at iron and steel works restarted on a very restricted scale, and with the low prices then prevailing was carried on at a heavy loss. Despite subsequent reductions in wages due to the operation of sliding scales and other mutual arrangements, and in the excessively high railway rates, which gave manufacturers less relief than had been hoped for, there still seems little hope of further reductions in the present prices of pig iron and steel, the cost of fuel delivered to the works being still too high.

From a fuel-economy point of view the position is most unsatisfactory, because at present the prices of coke as compared with those of coking coals delivered at the works offer little inducement to iron and steel makers owning self-contained plants to start up the coke ovens connected with their steelworks, since coke can be bought at prices below the cost of making it in their own ovens, even after crediting the values of all the by-products produced in the process. This condition is entirely abnormal; and it is hoped that with improved general trade, freedom from industrial disputes and unrest, and an increase in demand, more blast-furnaces and steelworks will be put into operation, and that the demand for the raw materials will then tend to re-establish more normal conditions in the coal and coke trade, and thus restore the balance in favour of pursuing a policy which ensures the greatest fuel economy in the operation of plants, which is so desirable in the national interests.

II.—Oil Fuel Supplies—Present and Future.

The Present Situation.—During the past year the Committee has had under consideration the important question of present and future supplies of oil fuel which are now needed for certain purposes (chiefly motor transport) for which at present coal cannot well be used. In this connection they have had the valued help of Mr. J. E. Hackford, who was co-opted on to the Committee on the nomination of the Institution of Petroleum Technologists.

As a first step towards the exploration of the subject, the Committee decided to collect authentic information as to the importation of petroleum products into the United Kingdom during each of the five years 1917-1921 inclusive. For purposes of reference the data so collected have been analysed and tabulated as follows:—

Table I.

Imports of Petroleum Products into the United Kingdom for the years 1917 *to* 1921 *inclusive.*

(Tons.)

	1917.	1918.	1919.	1920.	1921.
Crude Oil	1.65	—	31,388.0	17.417.1	426,151.0
Lamp Oil	456,905.4	528,644.6	544,185.0	574,828.2	536,575.6
Motor Spirit	422,080.9	584,724.3	602,324.8	629,511.5	768,287.5
Lubricating Oil	351,189.0	409,095.2	263,332.0	426,656.0	204,059.8
Gas Oil	120,400.0	149,375.0	115,511.1	206,018.4	304,786.6
Fuel Oil	1,835,759.1	3,515,020.8	1,105,855.0	1,425,045.6	2,255,822.2

TABLE II.

Imports of Petroleum Products for the year ending December 31, 1921.

[Customs *corrected* returns in tons, to the nearest decimal place.]

Origin.	Motor Spirit.	Kerosene.	Lubricating Oil.	Fuel Oil.	Gas Oil.	Crude Oil.	Others.	Total.
U.S.A.	414,165.7	440,410.6	192,185.3	820,610.4	292,181.3	7,533.9	300.5	2,167,387.7
Mexico	68,430.9	59,182.7	13,011.4	1,129,758.3	996.5	61,982.6	—	1,333,362.4
Dutch E. Indies	109,211.1	—	0.5	8,943.7	—	—	—	118,155.3
Dutch W. India Islands	5,649.3	—	—	—	—	—	—	5,649.3
Poland	—	—	19.8	—	2,184.0	—	—	2,203.8
Peru	9,092.9	—	—	—	—	—	—	9,092.9
Roumania	9,426.7	20,900.5	—	—	—	6.0	—	30,333.2
Russia	—	4,771.3	1,372.0	—	—	—	—	6,143.3
Persia	117,654.7	—	—	178,263.9	—	350,650.4	—	646,569.0
Other Foreign Countries	0.2	70.3	1,465.5	31,731.1	374.8	13.2	16.6	33,671.7
Total from Foreign Countries	733,631.5	525,335.4	208,054.5	2,169,307.4	295,736.6	420,186.1	317.1	4,352,568.6
British India	8,458.5	—	5.1	—	—	—	—	8,463.6
British W. India Islands	6,870.7	5,635.6	—	85,483.8	—	5,964.8	34.8	103,989.7
Canada	—	—	—	—	—	—	8.8	8.8
Egypt	6,314.4	5,605.1	—	1,042.0	—	—	—	12,961.5
Sarawak	10,571.8	—	—	—	—	—	—	10,571.8
Straits Settlements	2,439.5	—	—	—	—	—	—	2,439.5
Other British Possessions	—	—	0.2	—	—	—	4.4	4.6
Total from British Possessions	34,654.9	11,240.7	5.3	86.525.8	—	5,964.8	48.0	138,439.5
Total	768,286.4	536,576.1	208,059.8	2,255,833.2	295,736.6	426.150.9	365.1	4,491,008.1
Percentage from Countries outside the Empire	95.5%	97.9%	100.0%	96.1%	100%	98.6%	86.9%	96.9%

The Committee then proceeded to inquire into the origins of our present imported oil-fuel supplies, and for that purpose the statistics for the year ending 1921 were analysed (see Table II.) so as to discriminate between the various countries of origin, and also to show how much of our total imported supplies of petroleum and petroleum products are being drawn from within the Empire itself.

The Committee considers it important that attention should be drawn to the fact that, inasmuch as the home production of shale oil is now very small,[1] owing to the relatively low cost of production of imported petroleum, we are at present dependent almost entirely on countries outside the Empire for the supplies of natural petroleum and petroleum products, a most undesirable and dangerous state of affairs from every point of view.

The Gas and Coking Industries as Producers of Motor Spirit.—It would appear that the only practicable way in which home supplies of motor spirit and fuel oils can be extended is by the carbonisation of bituminous coals at temperatures between 600° C. and 1,200° C. By carbonising suitable British coals at high temperatures (1,000° C. to 1,200° C.) in gas retorts or fy-product coke ovens there can be obtained between 3 and 6 per cent. of the weight of the dry coal as anhydrous tar, and between 0.75 and 1 per cent. of its weight as refined benzole (motor spirit). It should be borne in mind, however, that, inasmuch as more than half of the coal so carbonised is for the production of hard metallurgical coke, the total production of motor spirit and tars by these methods depends very largely upon conditions in the iron and steel industries which fluctuate and at the present time are exceedingly bad. Supposing, however, that pre-war prosperity were restored to the iron and steel industries, a total high temperature carbonisation of some 40 million tons of coal per annum might reasonably be expected. Taking 1 per cent. of its weight as a probable outside limit for the ultimate production of refined benzole, the total potential production of the latter would not exceed 400,000 tons per annum, which is very little more than half the tonnage of the motor spirit actually imported into the country in the year 1921. Moreover, of this potential supply, nearly half would have to be drawn from the gasworks of the country, and it is at least problematical whether it would pay the gas companies to extract the benzole from their gas at present prices. Indeed, taking the present relative prices of gas and benzole, as well as the costs of recovering benzole from coal gas, it is probable that the cash value of the potential heating power of benzole is greater when left in the gas than it is when extracted therefrom and (after subsequent refining) sold as motor spirit.

1 *Thus in the year 1920 the amount of oil-shale mined in Great Britain was 2,840,859 tons, from which it may be estimated that no more than about 227,000 tons of oil would be produced.*

(To be continued.)

GENERAL NOTES.

THE NORWEGIAN INDUSTRIES FAIR, CHRISTIANA, SEPTEMBER, 1922.

The Fair was held for the third time in Christiana, the attendance was as good as the preceding years. The products included feeding stuffs, confectionery, textile products, machinery, tools, and electrical apparatus. The chief chemical industries of Norway, nitre, cellulose, and wood pulp, owing to trade depression, were not very prominent. There was a good display of pharmaceutical preparations, soaps, oils, varnishes, etc. Aluminium vessels made from Norwegian aluminium made a good show. The Norwegian exchange is the lowest of the Scandinavian countries, a fact that attracted many buyers, both from Norway and abroad.

The Secretary of the Fair is M. H. Sebelien.

EGYPT.

TENDERS INVITED.

The British Commercial Agent for Egypt has notified the Department of Overseas Trade that the Frontier Districts of Administration, Alexandria, is inviting tenders for the supply of consumable stores, oils and paints. Tenders, on the proper form accompanied by a provisional deposit of 2

per cent. of the total value of the tender, should reach the Director of Stores, Frontier Districts Administration, Alexandria, by noon on the 10th October next.

The schedule is rather extensive, and includes, among other goods, oils, paints and varnishes, hardware, brushware, canvas, lamp glasses, leather, rope (manilla and wire), soap, etc.

The schedule, conditions of tender, and specifications can be seen by United Kingdom firms interested, on application to the Department of Overseas Trade (Room 84), 35, Old Queen Street, London, S.W.1.

Local representation is essential. The Department will be pleased to supply United Kingdom firms not already represented with the names of firms who may be willing to act for them in this matter. (Ref.: 9008/F.E/G.P.)

CHEMICAL SOCIETY.

Ordinary Scientific Meetings and Lectures—Session 1922-1923.

1922.

Thursday, October 5th, at 8 p.m.; Thursday, October 19th, at 8 p.m. Thursday, October 26th, at 8 p.m., lecture by Sir W. H. Bragg, K.B.E., F.R.S., and Prof. W. L. Bragg, O.B.E., F.R.S.

Thursday, November 2nd, at 8 p.m.; Thursday, November 16th, at 8 p.m., and Informal Meeting.

Thursday, December 7th, at 8 p.m.; Thursday, December 14th,† at 8 p.m., lecture by Prof. C. H. Desch, D.Sc., Ph.D.; Thursday, December 21st, at 8 p.m.

1923.

Thursday, January 18th, at 8 p.m.

Thursday, February 1st, at 8 p.m.;

Thursday, February 15th, at 8 p.m.;

Thursday, February 22nd,† at 8 p.m., lecture by Princ. J. C. Irvine, C.B.E., F.R.S.

Thursday, March 1st, at 8 p.m.; Thursday March 15th, at 8 p.m.

Thursday, April 19th, at 8 p.m.

Thursday, May 3rd, at 8 p.m.; Thursday, May 10th,† at 8 p.m., Baeyer Memorial Lecture by Prof. W. H. Perkin, LL.D., F.R.S.; Thursday, May 17th, at 8 p.m., and Informal Meeting.

Thursday, June 7th, at 8 p.m.; Thursday, June 21st, at 8 p.m.

Annual General Meeting, Thursday, March 22nd, 1923, at 4 p.m. The Anniversary Dinner will be held the same evening.

† To be held in the Meeting Hall of the Institution of Mechanical Engineers, Storey's Gate, S.W.1.

Lectures.

The following lectures will be delivered during the coming session, and, by the courtesy of the Council of the Institution of Mechanical Engineers, will be held in the Lecture Hall of that Institution (Storey's Gate, Westminster, S.W.1):—

October 26th, 1922, at 8 p.m.: *The Significance of Crystal Structure*, by Sir William H. Bragg, K.B.E., F.R.S., and Professor W. L. Bragg, O.B.E., F.R.S.

December 14th, 1922, at 8 p.m.: *The Metallurgical Applications of Physical Chemistry*, by Professor Cecil H. Desch, D.Sc., Ph.D.

February 22nd, 1923, at 8 p.m.: *Some Constitutional Problems of Carbo-hydrate Chemistry*, by Principal J. C. Irvine, C.B.E., F.R.S.

May 10th, 1923, at 8 p.m.: *Baeyer Memorial Lecture*, by Professor W. H. Perkin, LL.D., F.R.S.

Informal Meetings.

The rooms of the Society will be open for Informal Meetings on November 16th, 1922, and on May 17th, 1923. Light refreshments will be provided and smoking permitted.

THE HOUSEHOLDER'S COAL.

The question of domestic coal prices continues to arouse interest in consequence of the prospect of further slight increases.

Inquiries in the district supplying the metropolis and other large centres with household fuel show that there has been nothing in the nature of a general increase by the collieries, and that no such increase is anticipated. It appears that one or two collieries have slightly increased their prices within recent weeks. These con-

cerns were, however, selling at exceptionally low prices, having made a greater reduction than the average when the pit-head figure slumped, and they have merely made such slight advances as to bring them in line with the other collieries of the district.

It is often asked who obtains the benefit from "high prices" now that the miners' wages are down to the minimum. It may be said at once that the collieries have not benefited by increased profit. This is borne out by recent official figures showing that the average loss on all coal drawn in the Eastern Federated Area—the districts which supply London and the South—was nearly 1s. 6d. per ton in the month of June.

As the following figures show, the actual pit-head price of those qualities of coal most largely used by the bulk of householders is very considerably less than one-half of the total.

	s.	d.
Pit price	19	0
Railway rate	9	6
Wagon hire	2	0
Distribution charges	12	6
(Includg. retailer's profits)	43	0

The latter item includes loaders' and carmen's wages, cartage expenses, sacks, siding rents, salaries and establishment charges, and profits.

Derby Brights are sold at an additional shilling per ton, the pit-head price being a shilling more than that of the fuel previously mentioned. In 1913 the pit-head price of this fuel was 13s., railway rate and wagon hire amounted to 7s. 4d., and distribution charges 6s. 8d., the total making 27s. The present price is thus about 63 per cent. above pre-war.

PRODUCTION OF CATALYSTS.

L. Duparc and C. Urfer.

Lithium, uranium, titanium, calcium, barium, strontium, and a few other metals are found to yield pulverulent nitrides when heated with nitrogen. These nitrides easily decompose when heated in a current of hydrogen, and this property is made use of in the production of synthetic ammonia.

To produce the metal in a suitable state, its oxide is caused to react with a reducing metal, such as aluminium. The resulting pulverulent mass consists mainly of the reduced metal in a very finely divided and pure state distributed over the surface of the alumina. The catalyst thus prepared is very valuable for the production of synthetic ammonia at comparatively low temperatures and at atmospheric pressure.—*Brit. Pat. 140,061, 1921. (Journal of the Society of Dyers and Colourists.)*

New Patents.

This list is specially compiled for *Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

22781—Boake, Roberts, & Co., Ltd.—Distilling and fractionating apparatus. Aug. 22.

23672—Casale, L.—Apparatus for catalytic synthesis of ammonia. Aug. 24.

23083—Fairlie, A. M.—Acid plant equipment. Aug. 25.

22888—Gradl, J.—Manufacture of artificial manures. Aug. 22.

Specifications Published This Week.

184206—Williams, J. G.—Process of manufacturing soluble phosphates.

184211—Withers, J. S.—Method and means for utilising the heat contained in the fuel residues of furnaces.

167143—Little Inc A.D.—Process of preparing cellulose butyrate.

184244—Chemische Fabrik Greisheim Elektron.—Process for the electrolytic production of potassium bi-carbonate from potassium chloride solutions.

184279—Dale, A. G.—Apparatus for the analysis and recording of gases.

184284—Galbraith, W. L.—Manufacture of amines from phenolic compounds.

Abstract Published This Week.

Urea.—Patent No. 182331.—Mr. J. Y. Johnson, of 47, Lincolns Inn Fields, London, has Patented in this country a process for the manufacture of urea.

It is carried out by forcing a mixture of ammonia and carbon dioxide into an autoclave, the gases are brought to the necessary pressure by expelling either or both of them from solutions capable of giving them off, by means of heat. By way of example, a concentrated solution of ammonium carbonate or carbamate is forced into a heated column, the gas mixture produced passed through a cooler at about 110-150° C., and the condensate run into an autoclave where it is heated at 130-150° C., until the conversion into urea no longer proceeds. The autoclave may be filled and discharged either at intervals or continuously, or the process can be carried out with single charges, when the column is replaced by a pressure resisting vessel. The unconverted gases are expelled from the urea solution and used together with fresh gases, to saturate the exhausted liquid from the column for further use. The gaseous ammonia and carbon dioxide may be generated in separate columns, for example, from aqueous ammonia and sodium or ammonium bicarbonate solution respectively, or one of the gases may be forced into the autoclave by means of a compressor.

Messrs. Rayner & Co. will obtain printed copies of the published specifications, and forward on post free for the official price of 1s. each.

THE CHEMICAL NEWS,

VOL. CXXV., No. 3259

THE INSTITUTE OF METALS.

ANNUAL MEETING, SWANSEA, SEPTEMBER 20TH, 1922.

(*Continued from Page* 165.)

Summary of Paper on "*THE COPPER-RICH ALUMINIUM-COPPER ALLOYS,*" *by* D. STOCKDALE, B.A., *presented at the Annual Autumn Meeting of the Institute of Metals, held in Swansea, Thursday, September* 21*st*, 1922.

The structures of the alloys of copper with aluminium up to 20 per cent. of aluminium have been investigated by Stockdale, who used the thermal data supplied by a study of the cooling-curves of the alloys and by quenching experiments in conjunction with microscopic examination in order to obtain the equilibrium diagram more exactly. He discredits the opinion that the addition of small quantities of aluminium to pure copper raises the freezing point of that metal, and shows that the minimum in the liquidus curve at 1,031° C. with 8.3 per cent. of aluminium is a true eutectic point. A small arrest point at 1,017° with alloys containing between 16.5 and 18 per cent. of aluminium has been discovered, but there is no indication of a minimum in the liquidus at about 16 per cent.

Copper, at 1,000° C. can hold only 7.4 per cent. of aluminium in solid solution; at 500° C. and at lower temperatures it can hold 9.8 per cent., although to obtain such an alloy a long annealing is required. The β solid solution breaks down above 350° C., and Andrew's observations on the and δ constituents have been confirmed. That portion of the diagram concerning the β and field has been radically altered.

The paper was fully illustrated by microphotographs.

Summary of Note on "*THE CLEANING OF ALUMINIUM UTENSILS,*" *by* R. SELIGMAN, PH.NAT.D., *and* PERCY WILLIAMS, B.SC., *presented at the Annual Autumn Meeting of the Institute of Metals, held in Swansea, Thursday,* 21*st September*, 1922.

For nearly half-a-century the difficulty of cleansing aluminium has hindered its entry into household and factory. This difficulty has been due to the fact that the metal is freely dissolved by hot soda solution, the most common detergent. The difficulty disappears entirely if the simple device be adopted of adding very small quantities of sodium silicate to the soda. Some years ago the surprising observation was made that aluminium was immune to attack by water-glass solutions, which at once suggested that the well-known detergent properties of such solutions might be enlisted for cleaning the metal. This was done with complete success. Water-glass is, however, an inconvenient material to put into the hands of the general public, and the problem could not, therefore, be regarded as completely solved. Later it was found that even small quantities of sodium silicate in soda solutions produce the same effect as a solution of water-glass. For example, the attack by a 5 per cent. soda solution is immediately arrested by the addition of an amount of sodium silicate equal to 1/100 of the soda in the solution.

By this observation the problem may be considered solved, because detergents consisting of a mixture of soda and sodium silicate are articles of commerce and readily procurable in most parts of the world. Among those which have been used with complete success are compounds sold for domestic purposes under the following trade names: "Carbosil," "Pearl Dust," and "Aquamol." Boiling solutions made up with London tap water and containing 0.5 per cent. and over of these materials remove grease readily without affecting the aluminium in any way.

Summary of Paper on "*THE EFFECTS OF OVERHEATING AND MELTING ON ALUMINIUM,*" *by* W. ROSENHAIN, D.SC., F.R.S., *and* J. D. GROGAN, B.A., *presented at the Annual Autumn Meeting of the Institute of Metals, held in Swansea, Thursday,* 21*st September*, 1922.

The work described in this paper was undertaken to ascertain whether certain forms of treatment in the melting and remelting of aluminium would bring about in the metal deterioration approximating to the condition generally described as "burnt" aluminium. It has been stated that exposure to an unduly high temperature during melting, and also repeated remelting of the same material, even at

ordinary melting temperatures, brings about such deterioration.

Both kinds of treatment were tried.

High grade aluminium was poured at temperatures up to 1,000° C., and also at the usual pouring temperature after heating for some hours at 1,000° C. The castings so obtained were rolled to sheet form and tested in the annealed state. No deterioration in the metal could be detected.

High grade aluminium, and also aluminium containing ¾ per cent. each of iron and silicon were cast to ¾ inch slabs and rolled to 0.01 inch sheet. This sheet was melted and cast, and the whole process repeated ten times. Test pieces cut from sheet 0.05 inch thick from each melt gave figures which indicated no systematic change in quality of the metal.

Summary of Paper on "*THE STRUCTURE OF EUTECTICS,*" *by* F. L. Brady, M.Sc., *presented at the Annual Autumn Meeting of the Institute of Metals, held in Swansea, Friday, 22nd September*, 1922.

The paper deals with the structures exhibited by eutectics, mainly those between metals and metallic compounds. An attempt has been made to correlate the micro-structure of a solidified eutectic with the physical properties of the component metals. The surface tension of the molten metal, and the cohesive force acting during crystallisation seem to be the main forces influencing the final structure. The eutectics examined, which include those between metals whose physical forces are known, fall quite decidedly into three classes. The terms "globular," "lamellar," and "angular," have been suggested as convenient terms for these divisions. The structures agree well with what would be expected from theoretical considerations of the effects of surface tension and cohesion.

Reference is made to structures in eutectic igneous rocks, and an examination has been made of earlier work on the effect of rate of cooling on the size of the individual phase particles in a eutectic.

Photomicrographs are given of characteristic structures of the various alloys examined, and an account is given of the methods of polishing the alloys, and a list of the etching reagents found most suitable. It is hoped that the paper may lead to further investigation of the eutectic structure as a means of comparing the properties of the component metals or compounds in other cases than those specifically dealt with.

Summary of Paper on "*THE ANTIMONY-BISMUTH SYSTEM,*" *by* Maurice Cook, M.Sc., *presented at the Annual Autumn Meeting of the Institute of Metals, held in Swansea, Friday, 22nd September.* 1922.

Several workers have investigated the equilibrium diagram of these two metals, and though the opinion that the system is isomorphous is generally held, the diagram has never been completed. Early investigators gave only the liquidus curve, and Huttner and Tammann, in 1905, gave, in addition to a new liquidus curve, part of the solidus which they found to be horizontal at 266° + 4° C. and extending from 0 to 70 per cent. of antimony.

In the present work very thorough thermal and microscopic investigations have been made. The results obtained, in addition to those from quenching and annealing experiments, show that the two metals form an isomorphous series of alloys. The liquidus curve is perfectly smooth, and the solidus is horizontal at 270° C. up to 60 per cent. of antimony, after which it rises steeply to the freezing point of antimony. Chill cast and slowly cooled specimens reveal duplex structures, but with prolonged annealing—550 hours at 275° C.—the alloys become homogeneous.

Twin crystals and peculiar banded effects were observed in some of the annealed specimens. It is supposed that the twin crystals have been formed during the solidification of the alloy by stresses due to expansion, and have grown to visible dimensions on annealing. The nature of the "bands" has not been definitely ascertained, though they are not considered to be slipbands.

Summary of Note on "*THE CAUSE OF RED STAINS ON SILVER-PLATED WORK,*" *by* A. Jefferson, *presented at the Annual Autumn Meeting of the Institute of Metals, held in Swansea, Friday, September* 22*nd*, 1922.

The red stains sometimes observed on finished articles which have been electro-silver plated cause considerable annoyance, and their origin has been somewhat of a

mystery to those engaged in the trade.

The occurrence of the trouble in individual works is often intermittent, and by some has been considered seasonal and to be *particularly prevalent in hot weather.* The Sheffield Silver Trade Technical Society appointed a Committee to discuss the matter and subject it to experimental study. With a *view to investigating* the matter thoroughly and completely, it was decided to commence with the basis metal, and to make the test independent of the *peculiarity of any one maker's metal,* twelve nickel silver discs were obtained from stock ingots of three separate firms and given to four members of the Committee, three to each. All the discs were distinctly marked and subjected to the various processes necessary, no special care being taken to either cause or prevent any unusual result. After clearly marking the places where defects appeared on the prepared surfaces, the discs were all silver-plated at one time in one vat, and afterwards were subjected to the various processes of finishing and polishing, for which different compositions and rouges were used. The results of this final process were carefully compared, and it was found and definitely established that the red stain was caused by the indiscriminate use of rouge in the finishing and polishing processes, through the absorption of the rouge into the open pores of the heated surface, the heat being evolved by the friction of the hand or finishing "Dolly." A practical holloware finisher proved this by taking a perfectly finished disc and putting a distinct red band about three inches broad down the centre. It was stated that if a polisher or finisher would refrain from applying rouge to an over-heated surface and go to a fresh part of the surface, then return to the now cooled original part of the surface, red would not arise.

Summary of Paper on "INTERMETALLIC ACTIONS. THE SYSTEM THALLIUM-ARSENIC," by Q. A. MANSURI, B.A., M.Sc., *presented at the Annual Autumn Meeting of the Institute of Metals, held in Swansea, Friday, September 22nd,* 1922.

Mr. Q. A. Mansuri, B.A., M.Sc., by means of thermal analysis and microscopic analysis, has shown that thallium and arsenic do not act chemically with each other, nor do they form solid solutions. They alloy in all proportions and the equilibrium diagram of the system is a perfect case of the immiscibility type.

First, arsenic dissolves in molten thallium and lowers its freezing point until a solution of 8.01 per cent. arsenic freezes at the eutectic temperature of 215° C. Then the freezing points of the alloys gradually rise to 240° C. All alloys containing from 13 to about 40 per cent. arsenic begin to freeze at 240° C., and are made up of two layers—the upper layer rich in arsenic while the lower rich in thallium. After about 40 per cent. arsenic, to nearly pure arsenic, the solution is uniform and the two layers disappear.

A method of taking the cooling curves of *volatile substances has been explained.* It has been shown that by heating such substances in evacuated and sealed glass tubes and applying the hot junction of the *couple in close contact with the outside of* the glass tube the couple is almost as sensitive as when dipped in molten substances.

Summary of Paper on "NEW FORMS OF APPARATUS FOR DETERMINING THE LINEAR SHRINKAGE AND FOR BOTTOM-POURING OF CAST METALS AND ALLOYS, ACCOMPANIED BY DATA ON THE SHRINKAGE AND HARDNESS OF CAST COPPER-ZINC ALLOYS," by F. JOHNSON, D.Sc., *and* W. GRANTLEY JONES, *presented at the Annual Autumn Meeting of the Institute of Metals, held in Swansea, Friday, 22nd September,* 1922.

In this paper the authors describe two new forms of apparatus:—

(*a*) For determining the total linear shrinkage of cast metals and alloys;

(*b*) For producing cast bars by a bottom-pouring method, the molten metal flowing from a specially heated crucible into the mould and the rate of flow being controlled by a lever-operated stopper.

Both forms of apparatus have been used in investigating the shrinkage and hardness of chill-cast copper-zinc alloys.

As regards the shrinkage values of these alloys, they are found to be higher in general than those obtained for sand-cast bars by previous investigators. The curve illustrating the relationship of shrinkage to composition confirms most of the features formerly discovered by Turner and Murray, but no minimum at 60 per cent. copper is found.

In making the alloys pure electrolytic metals were used, whilst re-melted castings were excluded from the investigation. Most of the alloys were poured at a temperature interval of approximately 115° C. above their liquidi, and the mould was kept at a constant temperature by means of an outer jacket of water maintained at the boiling point.

The alloys were prepared in a separate coke-fired melting furnace, and transferred thence to the bottom-pouring apparatus, which is illustrated and described in detail. The advantages afforded by the use of this apparatus are many, viz.:—

i. Control of pouring temperature;
ii. Facility for registering temperature of metal;
iii. Absence of delay between attainment of required pouring-temperature and release of metal into the mould;
iv. Control of rate of pouring;
v. Exclusion of dross from stream of metal, thus obviating the necessity for skimming;
vi. Mitigation of "zinc-fume."

The hardness of the bars was determined, both as cast and after annealing. Uniformity was not exhibited by the bars as cast, but was secured by annealing. In the case of the annealed bars, the hardness numbers both by the Brinell and Shore (scleroscope) methods were plotted against composition. The Brinell curve showed an increase of hardness over the range 100 to 88 per cent. copper. From 88 to 72 per cent. copper the hardness was constant, a slight fall setting in at about 72 per cent. copper and persisting to 63 per cent., at which point a rapid increase set in with the appearance of the beta constituent. With the exception of a small dip in the curve between 53 and 50 per cent. copper the increase is maintained to 45 per cent. copper.

The changes of scleroscopic hardness with composition are of a similar character to those revealed by the Brinell test, but less pronounced, whilst over the range 60 to 53 per cent. copper, no increase of hardness is shown, such as that shown by the Brinell test. This would indicate a very slight difference, scleroscopically, between the beta and alpha phases. The top faces of the bars as cast are slightly softer than the bottom faces, owing to slower rate of cooling, and although this difference is diminished by annealing, it is not entirely eliminated in every case.

The annealed bars (containing 100 to 57 per cent. copper) were cold-rolled, the reduction in thickness being approximately 50 per cent. The hardening capacity of the alpha brasses under cold-work increases rapidly with increase of zinc up to a maximum in the neighbourhood of 75 per cent. copper. The rolled strips, after close annealing, were again tested for hardness, the results confirming those obtained on the bars as cast and annealed, with the exception that the range of uniform hardness is slightly restricted and the succeeding fall (between 70 and 63 per cent. copper) is more pronounced.

Summary of Paper on "THE HARDNESS OF THE BRASSES AND SOME EXPERIMENTS ON ITS MEASUREMENT BY MEANS OF A STRAINLESS INDENTATION," by F. W. Harris, M.Sc., *presented at the Annual Autumn Meeting of the Institute of Metals, held in Swansea, Friday, 22nd September,* 1922.

The object of this research was to make a careful study of the hardness of the brasses; and the theoretical conceptions surrounding the question of hardness and its relation to constitution were first discussed. For performing the tests, it was decided that the Brinell machine would be the most suitable apparatus to use in this instance.

Before the main research was commenced, preliminary investigations were carried out in order to become fully cognisant with, and to measure the effect of, the various factors influencing the hardness. These experiments suggested the possibility of obtaining a value for the fundamental hardness of a material before strain set in.

The theories generally advanced with regard to the connection between hardness and internal constitution have been in the main substantiated. There are certain anomalies, however, which can only be explained by adopting a modified idea of the existing constitutional diagram.

A slight maximum was shown in the middle of the alpha phase, and a small depression in the beta phase.

A curve was established showing the "absolute" hardness for the series, as compared with the Brinell hardness. This latter curve was found to agree in general form with the ordinary one, but was somewhat less sinuous.

The author's curves show a general agreement in type with those of other workers, and confirm the maximum in the alpha phase shown by Meneghini and Turner and Murray, although throughout the series they are considerably lower in hardness value than those of the latter.

BRITISH ASSOCIATION.

SECTION B—CHEMISTRY.

PART II.—SOME RESEARCH PROBLEMS IN THE CARBOHYDRATES.

STARCH

(WITH MR. JOHN MACDONALD, M.A., B.Sc.)

(*Continued from Page* 170.)

Turning to the problem of the constitution of starch, we encounter very much the same difficulties as have already been referred to under the heading of cellulose. The importance of the compound, its manfiold technical applications, and the special appeal its study makes to the biologist have alike combined to produce a voluminous and somewhat scattered literature. If, however, we eliminate unsupported or contradictory results the following evidence as to structure emerges. Starch, when purified from constituents containing nitrogen and phosphorus, possesses the formula $(C_6H_{10}O_5)_x$, and the molecule consists entirely of glucose units. Further, three hydroxyl groups are present for every six carbon atoms, but, as in the case of cellulose, this does not necessarily imply that each glucose residue contains three unsubstituted hydroxyl groups, or that their distribution is symmetrical. The primary reaction of starch, which must be accommodated by a structural formula, is the production of maltose by the action of diastase.

The first essential is the identification of the unit of which the starch molecule is composed, and here, as in the case of other polysaccharides, molecular weight determinations give results of doubtful value. At the present time there is little tendency to regard starch as a highl ycomplex glucoside in which a large number of hexose residues are mutually condensed together, and the view prevails that the polysaccharide is derived from a comparatively simple anhydro-sugar by profound polymerisation. Attention may be focussed on three formulæ based on such ideas.

The unit of starch has been claimed to be:—

1. β-glucosan . . . (Pictet)[19]
2. anhydro-maltose . (Karrer)[20]
3. triamylose . . . (Pringsheim)[21]

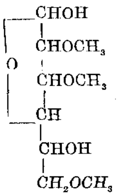
It is possible to test these views by the methylation method.

The first successful methylation of starch was effected by Denham and Woodhouse,[22] and the reaction was afterwards adopted by Karrer.[23] He was, however, unable to complete the alkylation, the substitution being arrested, as we ascertained many years ago, when the methoxyl content was of the order 35 per cent. This value is slightly higher than that demanded for a dimethyl starch, but is considerably lower than that calculated for a trimethyl derivative. It is significant that Pringsheim encountered similar difficulty in methylating the amyloses, diamylose giving a tetramethyl compound, whilst α-tetramylose was converted into the corresponding octamethyl derivative. Pringsheim's combined results lead him to the conclusion that the molecule of starch is built up of not more than 4-6 glucose residues, and, on the whole, he is disposed to retain triamylose as the basis of the polysaccharide.

On the other hand, Karrer's view that starch is a polymerised anhydro-maltose rests upon very insecure evidence. The claim that the action of acetyl bromide on the amyloses gives practically quantitative yields of heptacetyl bromo-maltose has been adequately repudiated by Pringsheim. It is, moreover, possible to dispose completely of Karrer's formula for starch by the results now submitted.

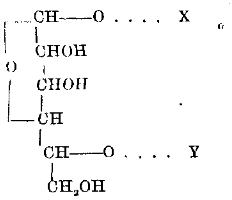
When the polysaccharide is methylated repeatedly by the methyl sulphate method, the reaction ceases when the methoxyl content is 37 per cent. It is to be noted that this maximum is not reached when the silver oxide and methyl iodide reaction is employed, as the substitution then stops definitely at the dimethyl stage. Now, the higher value for methoxyl corresponds exactly with the theoretical amount calculated on the basis that one hexose residue has acquired three methyl groups, while four are shared by two glucose residues. Ultimate analysis is also in agreement with this view. Hydrolysis of the methylated starch has shown that this is not a fortuitous coincidence, and we thus obtain a direct clue to the magnitude of the unit which goes to form the starch molecule.

When digested with methyl alcohol containing hydrogen chloride the methylated polysaccharide was converted into trimethyl methylglucoside and dimethyl methylglucoside. These were purified by distillation in a high vacuum, and thereafter hydrolysed to give the parent sugars. A totally unexpected result was encountered in that the trimethyl glucose actually isolated proved to be the crystalline form in which the methyl groups occupy the 2,3,6-positions. This sugar has been shown to have the constitution given in Formula XIV., and the linkage of one *glucose unit in the starch molecule is thus* established (Formula XV.). It is to be noted that this particular type of structure is not *present in maltose, but is characteristic* of cellobiose and lactose.

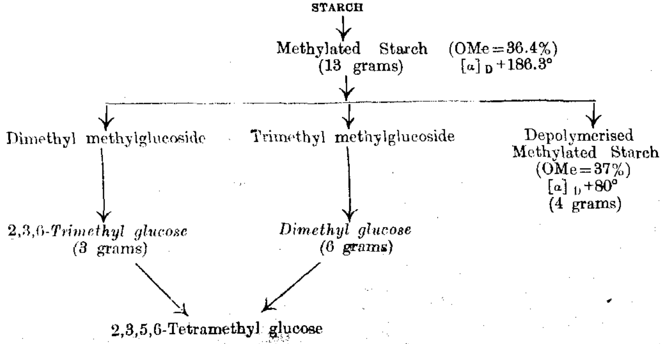


XIV.

XV.



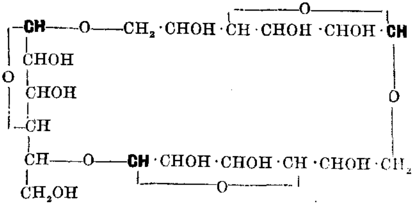
In order to accommodate the formatio of maltose from starch either one or tw additional glucose residues must be pre sent at X and Y in the unit. Before de veloping a formula which will fulfil th above conditions an outline of the re actions involved may be given:—



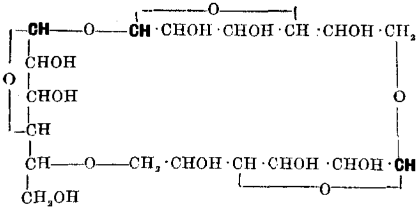
It will be seen that the removal of trimethyl glucose *and dimethyl glucose* in the molecular ratio of 1:2 is effected without alteration in the *composition* of any methylated starch which survives hydroly sis. The result is striking confirmation of the view that starch is based on a anhydro-trisaccharide in which two hexo

residues are linked in a different fashion from the third. One of these is constituted as in Formula XV., and the remaining two must be added in such a way that at least one pair displays the essential structure of maltose.[24]

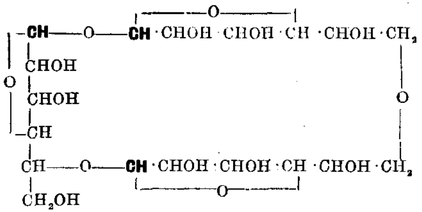
Four different structures may be built up to accommodate these factors:—



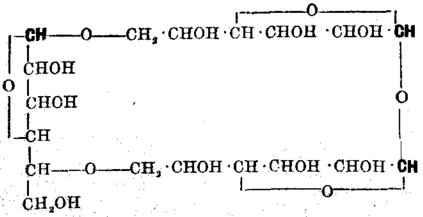
XVI.



XVII.



XVIII.



XIX.

The methylation process cannot discriminate between these possibilities, and with the data at our disposal it is inadvisable to make a definite claim in favour of any one of them. Each formula postulates that starch is derived entirely from the butylene-oxide form of glucose, and this we have shown to be the case. The formulæ are all consistent with the steric hindrance encountered in completing the methylation of starch, previous experience having shown that the alkylation of position 5 is difficult when position 6 of the glucose chain is already substituted.

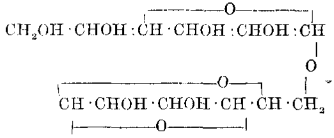
The formulæ differ in one important respect, as maltose may be obtained from form XVI. in two ways, and in only one way from each of XVII., XVIII., XIX. Pending the completion of further work on this subject we prefer formula XVI., but recognise that our results apply only to a purified rice starch.

One objection may, however, be discussed. In the formation of maltose no more than one molecule of this disaccharide could be obtained from one such unit. The maximum yield of the sugar would therefore be of the order 70 per cent. (74 per cent. calculated as maltose hydrate). Yields higher than this figure are quoted in the literature, but it may be remarked that most specimens of maltose do not behave as identical homogeneous chemical individuals in bacteriological tests. Further, von Euler and Svanberg,[25] who conducted the diastatic hydrolysis of starch under conditions in which the optimum hydrogen ion concentration was present, report that the yield of maltose formed is then 75 per cent. The small margin unexplained by our formulæ may be due to the synthetic action of the enzyme on the molecule of glucose liberated during hydrolysis. This suggestion is in agreement with von Euler's observation that the end point of his reaction was reached with extreme slowness. Another objection to the new structure is that the acetolysis of starch might result in molecular rupture in such a manner that cellobiose would be produced. So far, this disaccharide has not been encountered in the degradation products of starch, a result which is not surprising in view of the uncertainty attending the formation of cellobiose. It may also be mentioned that if starch is composed uniformly of the above anhydro-trisaccharide residues, it is difficult to explain the existence of polyamyloses other than those to which the general formula $(C_6H_{10}O_5)_3$ can be applied. Taking into consideration the yield of di- and tetra-amyloses obtained from starch, it is evident that they may possibly be accounted for in the fraction of the starch molecule which has not yet been converted into recognisable glucosides, but the alternative is also open that the polyamyloses may not all be structurally related to starch.

It is perhaps advisable to point out that the experimental results now presented demand the rejection of various formulæ for starch proposed from time to time by Karrer. His structures are based on a diamylose (anhydro-maltose), two formulæ for which have been put forward differing in the position of the anhydro-ring. The evidence he adduces in favour of these views is not convincing.

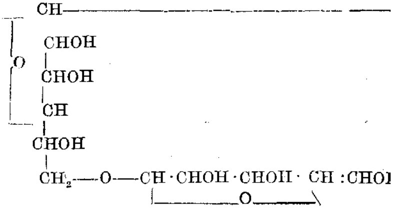
The first unit he gives is:—

XX.



A formula of this type is open to many criticisms, and would demand the direct production of 2,3,5,6-tetramethyl glucose from a methylated starch. It is needless to state further objections, as Karrer rapidly changed his views in favour of an alternative which is equally incorrect. The unit he prefers at present is:—

XXI.



It is clear that the only trimethyl glucose to which such a structure could give rise is the 2,3,5-form described by Irvine and Oldham.[26] No trace of this com-

pound was detected by us, and, moreover, the 2,3,6-variety of trimethyl glucose actually obtained cannot possibly be accommodated by Karrer's formula. For *similar reasons it can no longer be maintained* that starch is an aggregate of β-glucosan residues. Irvine and Oldham have proved that glucosan is convertible into 2,3,5-trimethyl glucose, and the same sugar should be formed on hydrolysing methylated starch if there is any structural relationship between glucosan and the polysaccharide. The result obtained is obviously opposed to such a view.

Our work has also thrown light on various other problems connected with the chemistry of starch, including the attachment of nitrogen and phosphorus to the molecule. These elements do not appear to be constituents of extraneous compounds, but form part of the polymerised aggregate. This is shown very clearly by the behaviour of nitrogenous starch, which was methylated in the first instance by the use of methyl sulphate and alkali. Thereafter the product was treated with silver oxide and methyl iodide, but contrary to expectation the whole of the material became converted into an insoluble additive compound with silver iodide. This behaviour does not extend to a purified starch, and finds an exact parallel in the case of glucosamine derivatives which, under identical conditions, form insoluble complexes with silver halides.[27] Obviously if nitrogen were present merely as part of an adventitious impurity only this component would be removed in the course of the silver oxide alkylation, and the fact that the total material was precipitated is a proof that the fragment containing nitrogen is difinitely polymerised to the starch unit. Similar considerations apply to the case of glycogen and have served to complicate our work on the alkylation of this compound. It has been established, however, that, as in the case of starch, the methylation of glycogen shows a tendency to be arrested when the methoxyl content is under 40 per cent. The separation of the methylated glucoses is not yet sufficiently far advanced to permit of their identification, but a publication on the exact relationship of glycogen to starch will not be long delayed.

Synthetic Dextrins.

(*With Mr. J. W. H. Oldham, B.A.*)

With the courteous permission of Professor Pictet we have applied the methylation process to the synthetic dextrins recently prepared by him.[28] These compounds are formed by the polymerisation of β-glucosan and, in properties and composition, *they closely resemble the natural* dextrins. It is, however, abundantly evident that the synthetic compounds differ structurally from starch as, although methylation was extremely tedious, complete alkylation was effected with the production of trimethyl derivatives. Contrary to expectation, hydrolysis of these compounds did not lead to the formation of 2,3,5-trimethyl glucose, although this sugar has already been obtained from β-glucosan by similar treatment. On the other hand, large quantities of 2,3,5,6-tetramethyl glucose were invariably formed, together with lower methylated glucoses in which the position of the alkyl groups is unknown. It follows from these results that the synthetic dextrins are complex polyglucose-glucosides, and it is interesting to note that they thus conform to the structural type suggested for cellulose by Hess. Although starch is convertible into glucosan and this, in turn, into the synthetic dextrins, it is evident that profound structural alterations must accompany each change.

Inulin.

(*With Dr. Ettie S. Steele, Mr. G. McOwan, M.A., B.Sc., and Miss M. I. Shannon, B.Sc.*)

The statement has been made that, of all the polysaccharides, inulin is the representative of which the structure has been most definitely established. The opinion is gratifying, but not altogether accurate.

Inulin is derived from fructose, and, until recently, there was no reason to doubt that the parent hexose was the well-known lævo-rotatory form of the ketose. This view is no longer tenable as, although inulin itself yields the normal form of fructose on hydrolysis, trimethyl inulin is converted into a *dextro-rotatory* trimethyl fructose. In similar manner, dimethyl inulin gives a dextro-rotatory dimethyl fructose. Each of these alkylated ketoses was proved to be a derivative of the "γ-fructose," which is a constituent of sucrose.

This result places inulin in a position which is quite unique, and the evidence is conclusive that the polysaccharide is entirely composed of γ-fructose residues, each of which retains three hydroxyl groups.

The many problems involved in the constitution of inulin have been discussed by us at some length in recent papers, and attention may now be restricted to the additional evidence we have secured. One important point left uusettled was whether the trimethyl γ-fructose obtained from trimethyl inulin is a single chemical substance or a mixture of isomerides. The question is fundamental, as only in the event of the methylated fructose proving to be a single individual are we justified in claiming that the hydroxyl groups in inulin are symmetrically disposed. The experimental difficulties in the way are formidable, as methylated fructoses of the γ-type are liquids and give no crystalline derivatives. By the following method, however, it has been possible to obtain the necessary information, and it is now established that only one form of trimethyl fructose is produced from inulin.

A large quantity of trimethyl inulin was digested with methyl alcohol containing hydrogen chloride under conditions which effected:—

(a) Depolymerisation,
(b) hydrolysis,
(c) condensation to give trimethyl methylfructoside.

The product was distilled in a high vacuum, and fractions were abstracted at frequent intervals while the hoiling-point remained constant. All the fractions showed the same refractive index and specific rotation. Moreover, the speed of hydrolysis of the fructoside, as indicated by polarimetric observations, was in each case the same and in each experiment the trimethyl fructose then formed showed identical physical constants. Of greater importance is the fact that all the specimens of trimethyl methyl-fructoside reacted in the same way when dissolved in acetone containing hydrogen chloride. Under these conditions trimethyl fructose monoacetone was formed, and here again the speed of the reaction measured polarimetrically showed no difference in any of the specimens.

There can be no doubt, therefore, that inulin is an aggregate of anhydro γ-fructose residues and that each of the units is identical.

As the exact structure of the methylated fructoses of the γ-type is not yet determined with certainty, it is needless to speculate here on the manner in which these residues are united. The subject has been engaging our attention for a considerable time, but is complicated by the readiness with which the methylated inulins undergo both polymerisation and depolymerisation.

It is not unlikely, bearing in mind the structure assigned to cellulose and starch, that inulin is based on a tri-anhydro-γ-fructose.

The structural discussion which I have had the honour to lay before you on one of the most important groups of natural compounds is admittedly incomplete, and no claim is made that the formulæ now submitted are final. But they at least indicate a new development in the chemistry of polysaccharides, and lines of further research are opened out which promise in time to reveal the intimate constitution of these substances. Much reliance has been placed on the validity of the methylation process as a means of determining structure, but it has to be remembered that most speculation of the kind on carbohydrates is now based on results obtained by this one particular method. The structure of glucosides, the nature of γ-sugars, the constitution of sucrose, maltose, and cellobiose, are all involved in current discussions on this subject, and all are based on the properties of the simple alkylated sugars.

Numerous details, such as the specific reactions of the individual hydroxyl groups in carbohydrate units, have still to be settled before the further problem of the polymerisation of polysaccharides can be adequately dealt with, but many features, for the most part unexpected, have been revealed.

The polysaccharides, like many other research fields, are, after all, not so complicated as they appeared when viewed from afar, and the close relationship now established between cellulose and starch, starch and lactose, inulin and sucrose, will, it is hoped, play a part in bringing within the range of exact experiment the structural study of all types of natural compounds related to the simple sugars.

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20 *Karrer*, *Natur. wiss.*, 1921, 9, 399.

Karrer and Smirnov, *loc. cit.*

21 *Pringsheim*, *loc. cit.*

22 *Denham and Woodhouse, loc. cit.*
23 *Karer, Helv. Chim. Acta*, 1920, 3, 620; *ibid.* 1921, 4, 185; 678.
24 *Purdie and Irvine, J.C.S.*, 1905, 87, 1022.
Irvine and Dick, J.C.S., 1919, 115, 593.
Haworth and Leitch, ibid., 809.
25 *Euler and Svanberg, Zeitsch. physiolog. Chem.*, 1921, 112, 207.
26 *Irvine and Oldham, J.C.S.*, 1921, 119, 1744.
27 *Irvine and Hynd, J.C.S.*, 1912, 101, 1128.
28 *Pictet, Helv. Chim. Acta*, 1918, 1, 226, *and subsequent papers.*
29 *Irvine and Steele, J.C.S.*, 1920, 117, 1474.
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BRITISH ASSOCIATION.

FUEL ECONOMY.

(*Continued from Page* 174.)

Low Temperature Carbonisation of Coal as a Future Source of Oil Fuels.—Therefore, it has to be recognised that the most promising internal supply of both motor spirit and fuel oils lies in the direction of the low-temperature carbonisation of coal, provided that methods can be devised for same which are sound both from the technical and the commercial points of view. A really successful solution of this problem is greatly to be desired, not only for the aforesaid reasons, but also because it would be a great factor in the abolition of the smoke nuisance, especially from domestic fireplaces. The Committee has paid close attention to the recent developments with regard to this matter which are taking place in this country. In this connection attention may be drawn to:—

1. The description of the operation of the experimental plant at Barugh, near Barnsley, as published in *Engineering* of October 28, 1921.

2. The Conference on low-temperature carbonisation which was held at Cardiff on April 20, 1922, under the auspices of the South Wales Institute of Engineers.

3. The paper read on April 3 last, on "The Influence of Structure on the Combustibility and other Properties of Solid Fuels," by Messrs. E. R. Sutcliffe and E. C Evans, before the London section of the Society of Chemical Industry (*Journ. Soc. Chem. Ind.*, Vol. xli., p. 196 T.).

4. The Report on Low Temperature Carbonisation recently issued by the Fuel Research Board (H.M. Stationery Office, 1922).

Taken together, these publications give a fairly comprehensive view of the present position of affairs in regard to the low-temperature carbonisation in this country. The Committee is in general agreement with the view recently expressed by the Fuel Research Board that, although we have not yet reached the stage when a final answer can be given to the question whether or not it will be possible to establish on sound industrial lines a new industry based on the carbonisation of the tens of millions of tons of coal per annum which are at present being consumed in the raw state in this country, yet as the result of the pioneering work which has been done during recent years by various organisations such knowledge and experience has been gained as affords some ground for the expectation that we are approaching a conditional solution of the matter.

There still seems to be some difference of opinion as to whether from the commercial point of view it will be better to carbonise at temperatures round about 600° C., or at somewhat higher temperatures (say, 700° C. to 750° C.), but this may be regarded as a minor issue. It seems now to be established, as the result of fairly large scale trials, that the average yields of the various products now obtainable by carbonising suitable British bituminous coals at a temperature of 600° C. will amount (on the weight of the dry coal carbonised) to about 7.5 per cent. of tars, and about 2.5 gallons per ton of motor spirit, besides about 3,500 cubic feet per ton of a rich gas of a gross calorific value (say) of about 800 B.Th.Us.,[2] and a 70 to 80 per cent. residue of smokeless semi-coke.

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2 *The Fuel Research Board's Report gave figures which would average about* 1,000*B.Th.Us., but the Committee has thought it better to adopt the more conservative estimate of* 800 *B.Th.Us. here.*

Seeing that the cash value of the semi-coke residue far exceeds that of all the other products put together, and also that the price of fuel oil in this country will probably also be determined by circumstances beyond our control, it seems as though the ultimate prospects of a low-temperature carbonisation industry will depend upon the price which the public will be willing to pay for a smokeless domestic fuel. There can be little doubt but that such a fuel, properly manufactured, is a very suitable one for domestic consumption; it burns freely and smokelessly, and also, according to Dr. Fishenden's recent experiments (*vide* Fuel Research Board Special Report No. ? it has a greater radiant efficiency than either coal or high-temperature coke. Its general adoption, however, will probably depend upon two other conditions being fulfilled. Firstly, it must be prepared and distributed in a form which will allow of its being freely handled without undue disintegration. Secondly, if its ash content could be cheaply reduced to a low figure by subjecting the coal to some washing process such as froth flotation or the like before it is carbonised, its attractiveness as a domestic fuel would be undoubtedly greatly increased. Indeed, it seems possible that public opinion might soon be educated to regard with favour well-manufactured smokeless semi-coke of better combustibility and of smaller ash content than raw coal.

From this point of view, the recent work of Sutcliffe and Evans upon the influence of porosity on the combustibility of solid fuels (*loc. cit.*) is of interest, inasmuch as it draws attention to a factor whose significance is not always sufficiently recognised in fuel technology. These authors consider the porosity of the cell walls of a carbonised fuel to be extremely important in determining its combustibility. Their suggestion that, before the coal is carbonised for the production of a free-burning smokeless domestic fuel, it should be finely pulverised and briquetted by pressure without the use of a binder, in order that the thermal availability of the resulting semi-coke may be raised to a higher level, deserves further investigation from both the technical and commercial standpoints, especially if it could be found practicable to combine it with some preliminary washing process in order to reduce the ash content of the semi-coke.

Supposing that further technical developments result in the establishment of a low temperature carbonisation industry for the manufacture of a smokeless domestic fuel, it is of interest now to forecast the effect of such developments upon the future home supplies of motor spirit and fuel oils. It may be provisionally assumed that the amount of coal which could be so carbonised to supply domestic fuel requirements would be at least 30 (and possibly even 50) million tons per annnm. Taking the former of these two figures, this would mean a possible production of about 100 million gallons (or about 350,000 tons) of motor spirit, and 600 million gallons (or about 2,750,000 tons) of anhydrous tars (fuel oils).

(To be continued.)

"THE DYERS' BIBLE."

British Users' New Record of Colour Countries: A Tie in Anglo-German Rivalry.

(From a Scientific Correspondent.)

After being held up for a couple of months by the printers' strike, the first instalment of the new "Dyers' Bible," or, to give it its official title, "Colour Index," has been published this week by the Society of Dyers and Colourists of Bradford, under the editorship of Dr. F. M. Rowe, of the Manchester College of Technology, assisted by Mr. C. Lea, M.Sc. Tech., and a large revision committee, on which the leading dyestuff manufacturers and dyestuff users of all classes are represented. Amongst professors who have helped forward the production are Professor A. G. Perkin, F.R.S., of Leeds; Professor G. T. Morgan, F.R.S., of Birmingham, and Professor Knecht, of Manchester.

One hundred and fifty copies of the proofs have also been revised by colour manufacturers everywhere with the exception of Germany. "We used every possible means to persuade Germany to come in, too," said Dr. Rowe in an interview, "but apparently after a meeting of all their dyestuffs manufacturers they refused.

"It may be remembered," Dr. Rowe went on, "that Schultz's 'Farbstofftabellen,' which the Index is intended to replace, was regarded as such an important

ook that when it was scarce during the ar the Americans made a photographic opy of it and circulated it throughout the nited States. The 1914 Schultz reckoned include by name all the commercially ade dyestuffs of which the constituents, ethod of preparation and properties were ublic knowledge. Since 1914 the whole tuation has, of course, altered. The full orking capacity of our dyestuffs industry now round about 35,000 tons a year. The nited States are not far short of that tal, whilst the old-established Swiss rms have developed their resources, and number of colour works have also been stablished in France and Iatly.

"As a result many firms are now placig on the market dyes which may not be ew, but at least have completely new ames, and one of the points of the Colour dex is to include all the alternative trade ames under which the dye is marketed tached to the particular composition of e actual chemicals concerned.

"We have brought up-to-date all the ientific and patent literature references, d made them as complete as possible. learly, it is important for a dye-user who quires a particular dye to be able to look up in such a Colour Index under any me by which he has known it in the st, and to find there a complete list of e manufacturers who now place it on the arket.

"It has taken us one year to get out the st part, but meantime sufficient matter r ten parts has been prepared for the inter. All told, there will be full particurs of about 1,400 individual colours, or 0 more than in the last edition of hultz, and there will be included quite a rge number of dyes which have never gured before in a work of this kind. It is rely an indication of the change in the orld situation regarding dyestuffs that in 22 a British society should be publishg a work of this nature which, it is antipated, will supersede German reference oks."

The dyes dealt with are those manufacred by more than one hundred dyeakers all over the world. Belgium, Holad, Spain, Russia and Czecho-Slovakia e represented by one firm apiece, and her countries in their order are: Japan 2, aly 2, Switzerland 5, France 17, United ates 29, Germany 32, Great Britain 82.

GENERAL NOTES.

MINISTRY OF AGRICULTURE AND FISHERIES.

Rural Party Line Telephones.

The Ministry desires to call the attention of farmers and others to the facilities now offered by the Postmaster-General for the co-operative use of a telephone service, which, from several points of view, should prove of very great value to residents in rural districts.

The Postmaster-General has issued a memorandum on this subject, in which it is stated that residents in rural districts are apt to think that a telephone is a luxury of town life which it is impossible to enjoy in the country except at a high cost. This is true if each person requires a separate exchange line, consisting of two wires over the whole distance between the exchange and his residence, to be provided for his exclusive use, but such a line is not necessary in order to enjoy most of the advantages of the telephone service. If a sufficient number of subscribers living on or near a country road leading to a town where there is a telephone exchange will agree to use one line, they can telephone as much as they please to people on that exchange for a moderate fixed charge which ranges from £4 to a little more than £4 10s. according to the number of subscribers per mile.

CO-OPERATIVE SELLING OF EGGS.

£15,787,034 Spent in Foreign Eggs in 1921.

The people of this country paid the enormous sum of £15,787,034 in the year 1921 for imported foreign eggs, exclusive of imports from Ireland, which country exported in 1920 (mainly to Great Britain) eggs to the value of £14,307,720. There is no reason why the greater part of this money should not have been spent in the purchase of eggs produced at home. One of the best means of encouraging the increased production of eggs is to form Co-operative Egg and Poultry Societies.

From the Report of the Government Chemist upon the work of the Government Laboratory for the year ending March, 1922, we learn that the total number of samples examined in the course of the year, including those dealt with at the Chemical Stations, is 302,562, as compared with 308,675 in the preceding year, a decrease of 6,113.

ADMIRALTY.

Chemical work is performed for the Admiralty in connection with the Contract Department at Whitehall, the Naval Yards, the Engineering Department, the canteen inspections, the hospitals and schools, and the Medical Branch. The Contracts Branch of the Admiralty submitted 89 samples of foods on tender for report as to conformity with specification and opinion as to relative merits. The technical examining officers at the victualling yards forwarded 290 samples from supplies and from returned stores for examination and report, many of the samples being submitted with the object of preventing the issue of canned goods contaminated with metals.

Other samples to the number of 311 included ferrous and non-ferrous metals, fuel oils for boats, rubber washers and valves, soaps, fabrics for sail cloths, and paints.

The total number of samples for the Admiralty was 690.

CHEMICAL STATIONS.

In order to avoid delay in the examination of samples, chemical stations have been established at the more important seaports and one inland town of the United Kingdom, where samples are tested by Customs and Excise officers who have been specially trained at the Government Laboratory for this purpose.

As a check on the work of these officers, the residues from a certain number of samples tested by them are retested at the Government Laboratory. The number of such retests during the past year was 1,277. The results indicated that the testing work at the outport chemical stations is performed in a highly efficient manner.

HYDROMETERS, SACCHAROMETERS, AND GRADUATED VESSELS.

Hydrometers, for ascertaining the strength of spirits, and saccharometers, for use at breweries and glucose factories, are tested as to their accuracy, and graduated vessels of various descriptions for use in the Surveying Department are calibrated at the Laboratory before being issued to the officers of Customs and Excise. During the past year 3,008 such tests were made. In addition, three Sikes' hydrometers were tested for the National Physical Laboratory by comparison with the Revenue standard instruments deposited in this Laboratory.

Forty-six samples of imported manufactured tobacco and snuff were submitted for classification as to the proper tariff description and rate of duty chargeable if found to be admissible. Seventeen were found to contain prohibited ingredients, which rendered them inadmissible for importation.

Of home-grown leaf tobacco, which is being experimentally cultivated in Ireland, East Anglia, and the south of England, 74 samples were examined. Government assistance is furnished to the growers in certain districts, and recent information on the progress of the experiments is contained in the Journal of the Department of Agriculture and Technical Instruction for Ireland, Vol. XXI., page 200, and the Eleventh Report of the Development Commission, pp. 49-50.

DISPOSAL BOARD.

A number of steel and bronze bars was examined for this Department in order to facilitate grading. The recovery of radium from one batch of luminous dials, gun-sights, etc., was completed, and upwards of 300 milligrams of radium bromide in a state of purity exceeding 90 per cent. was obtained. In addition to this, some 100 milligrams of highly concentrated material was recovered in a state suitable for immediate use. All this reserve of radium is likely to be put to its proper use and will assist investigations.

POWER GAS FROM SEWAGE.

The Birmingham, Tame and Rea District Drainage Board, in their report last week, make the following statement, which is of interest to the works manager and chemist alike, as to the practical application of gas, derived from sewage, for power purposes. As a result of experiments, it has been found possible to drive a pump which lifts sewage from the well adjoining the engine house to the irrigation land. The gas available for driving the engine has varied in amount, but it has been possible to keep the well free of sewage, although a gas holder for storage purposes had not been erected. The experiment is regarded by the Board as holding great possibilities of further expansion, but the economic aspect is a matter for further consideration.

CANADA'S EXCELLENT HARVEST: WORLD'S CEREAL PRODUCTION.

The Canadian Government communicates by telegram to the International Institute of Agriculture new data as to the production of cereals, which show an increase on the already favourable estimates made previously. In fact, the production this year will be far greater than last year's and amongst the highest yet recorded. The production reaches 10.6 million metric tons of wheat (a 70 per cent. increase on the average during the five years 1916-20), 1.3 million metric tons of rye, 1.7 million metric tons of barley, and 8.6 million metric tons of oats.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

THE COMMITTEE OF THE CHEMICAL SECTION, ELECTED MAY 5TH, 1922.

Chairman, Leonard E. Vlies, F.C.S., F.I.C.; Vice Chairman, H. F. Coward, D.Sc., F.I.C.; Secretary, David M. Paul, B.Sc., A.I.C.; Committee: David Bain, D.Sc., W. H. Bentley, D.Sc., F.C.S., David Cardwell, M.Sc., F.I.C., R. H. Clayton, B.Sc., J. A. Russell Henderson, D.Sc., F.C.S., Harold Moore, M.Sc.Tech., F.C.S., A.I.C., Rona Robinson, M.Sc., F.I.C., F. C. Thompson, B.Sc., D.Met., J. C. Withers, Ph.D., A.I.C.

Meetings are held monthly during the session from October, 1922, to May, 1923.

CORRESPONDENCE.

NUMERICAL RELATIONSHIP BETWEEN THE ELEMENTS, STRONTIUM, TIN, AND CHLORINE.

TO THE EDITOR OF THE "CHEMICAL NEWS."

SIR,—In the issue of your paper of Jan. 27th, containing the description of the numerical relationship between calcium and strontium, it is pointed out that tin and chlorine are related as number and logarithm to the Napierism base, following a rearrangement of atomic numbers with respect to 1106.

In the following study, an attempt is made to understand the nature of the relation between tin and chlorine, while adhering closely to the systems of atomic numbers in use. The atomic number of chlorine is 35.46137 when the logarithm to the base ten is 1.5497556, that of Sn.119 being 0755470. The logarithm of chlorine is the association of the first figures of the logarithm of chlorine, and practically the logarithm of tin following the first cipher.

Let Na.(23) be the number of Cl., then the logarithm of Cl. is 0.737783. Twice 2737783 (*Chem. News*, July 8th, 1921) and the constant 13 gives 13547556. This is equal to 2 × 46 × 147256.

(O.=16.$\log_e$ 256=94001.).

147256 : 8 =2300875. Log. 230087= 3618932.

618932=log. 1.290124 × 5594546 (Fe.)

119 × 147256 = 1752346 = 2 × 876173.

Log. 1752346=2436202.

123 × 147256 = 18112488 = 2 × 9056244.

The logarithm of 18112488, 2579782 is related to the equivalent weight of iron, 27972, with the interpolated five or with the constant 13.

10.13 is the atomic number of chlorine, on the system Ca.=11.45 (*Chem. News*, Jan. 27th).

Let Sr. = 905625, Na. = 24.3326.

Sodium is now the horizontally adjacent element magnesium. From this examination it follows that 119 and 123 are closely related, sodium 23 and chlorine 35.46, being the atomic numbers with which the relationship is established. When Sn. = 226.45, the number 123 is then 234.063, calculating on Sn.=119, and log. Sn. (119) is 34062 calculating on 123. It is opportune, here, to advocate the adjustment of the present system of atomic weights to the one of Cl. = 35.5. Co. = 59031.—I am, Yours, &c., A. SAKOSCHANSKY.

NOTICES OF BOOKS.

A Systematic Qualitative Chemical Analysis, by G. W. Sears, Ph.D. Pp. VI. + 119. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd., 11, Henrietta St., W.C.2. 1922. Price 8s. 6d.

This contribution to the literature of Analytical Chemistry is divided into three parts, with an appendix on the preparation of reagents, etc.

Part I. is introductory, and deals in a clear manner with the Ionic Theory and the Law of Mass Action, with special reference to their application to the methods of Qualitative Analysis.

A systematic scheme for the separation of metals (cations) is described in Part II. It has many original features, thus Group I. includes not only the cations Pb, Ag, Hg, but also Bi and Sb, since ammonium chloride is used as the group reagent. Again Group III. includes Al, Cr, Zn, Mn, Fe, Co and Ni, separated into an Aluminium division and an Iron division, the former including Al, Cr, and Zn. It seems doubtful whether this arrangement is altogether satisfactory.

In Part III. a new method is given for the identification of acids (anions). An attempt is made to follow the procedure of metal analysis, since one sample is used and the acids are separated into four groups by precipitation methods. In this way 25 acid radicles (anions) may be detected, and are classified into the following groups:—

I. Anions whose Ag- salts are insoluble in cold dilute nitric acid.

II. Anions whose salts decompose on boiling in acid solution and give volatile oxides.

III. Anions whose Ag- salts are soluble in acid but insoluble in warm neutral solution.

IV. Anions whose Ag- salts are soluhle.

The author does not lose sight of the fact that Qualitative Analysis is a part of General Chemistry and under the guidance of a teacher well acquainted with his scheme, students might quickly acquire, not only the principles of analysis, but also of general chemistry from the standpoint of the Ionic Theory. J.G.F.D.

New Patents.

This list is specially compiled for the *Chemical News*, by Messrs. Rayner (Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

23427—Buckman, B. H.—*Liquid-metering apparatus.* Sept. 1.

23571—Calvert, G.—Manufacture of substances containing a methyl radicle. Aug. 30.

23561—Farbwerke, L.—Manufacture of methane. Aug. 30.

23441—Hansen, I. J.—Method of treating containers, etc., of iron for manufacture of sodium peroxide. Aug. 29.

23473—Jacobson, B. H.—Manufacture of anhydrous metal chlorides. Aug. 30.

23362—Klipstein & Co.—Process of manufacturing derivatives of carbazols. Aug. 29.

Specifications Published this Week.

184501—Jackson, W. J.—Process for treating ores.

184527—Dossett, J. M.—Process of and apparatus for crystallizing copper sulphate.

165085—Anon. de Products Chimiques Establissements.—Process for the production of acetaldehyde from acetylene.

184625—Imray, O. Y.—Manufacture of dialkylamides of nicotinic acid

184627—Johnson, J. Y.—Manufacture and production *of oxalic acid.*

184639—Harris, H. — Apparatus for refining metals.

Abstract Published this Week.

Alkaloids. — Patent No. 182986. — Messrs. Howards & Son, of Uphall Works, Ilford, Essex, have obtained a Patent for a process for obtaining Amino derivatives of Hydrocinchona Alkaloids. They are obtained by reducing the corresponding nitro compounds in neutral or nearly neutral solution. Suitable reducing-agents are metals in the presence of a solution of a salt, for example zinc or iron in presence of ammonium sulphate, tin and an ammonium salt, and hydrogen sulphide, the nitro compound may be dissolved in alcohol, or dissolved in water as a salt. In an example nitrohydroquinine hydrochloride is reduced with iron filings and ammonium sulphate solution at 100° C.

Messrs. Rayner & Co. will obtain printed copies of the published specifications, and forward on post free for the official price of 1s. each.

THE CHEMICAL NEWS,

VOL. CXXV., No. 3260

AN APPEAL ON BEHALF OF RUSSIAN MEN OF SCIENCE.

Chemical Society,
Burlington House,
Piccadilly, W.1.
28th September, 1922.

DEAR SIR,—In September of last year, in consequence of the information received as to the deplorable conditions under which Russian men of science were placed, I issued an appeal to the Fellows of the Chemical Society to assist in the alleviation of the acute distress prevailing amongst their colleagues in Russia.

I have to announce with great satisfaction that in response to this appeal the sum of £214 2s. 7d. was received, besides numerous valuable parcels of clothing, underclothing, boots, and books. It will be seen from the statement given, that of this sum, £170 has been devoted to the purchase of clothing, which has been distributed amongst our colleagues in Ekaterinburg, Moscow, and Petrograd. In addition to this, three cases containing clothing and books have been despatched to Moscow and Petrograd.

The difficulty with which we were confronted, namely the uncertainty as to whether parcels sent from England would reach their proper destinations, has now happily been overcome, definite proof having been received in every case that the goods have reached those for whom they were intended.

In a letter written by one of the workers of the European Student Relief Society to the Friends' Relief Committee, the following passage occurs:

"The Chemical Society in England recently sent out some scientific journals, etc., through the Friends. They have been entrusted to me for distribution, and when I told some of the Moscow Professors of their arrival, their eagerness to see them was like the eagerness of the children in the famine areas to get bread. You can assure all donors that every journal would be properly circulated in the faculty concerned and be retained in the library."

It will be seen from this how urgent the need still is for scientific books; and from information received from the Committee of Russian Men of Science (a member of which visited this country last Spring) the need for every kind of scientific apparatus appears to be equally pressing.

Notwithstanding the useful work that has been accomplished by the different organisations formed to relieve the wants of men of science in Russia, there remains much to be done, for there is every reason to fear that the necessity will be no less acute during the coming winter than it was last year. I therefore issue this appeal to Fellows of the Chemical Society, and to British chemists generally, to render every assistance within their power, in the confident hope that a generous response will be forthcoming.

In addition to donations of money to be devoted to purchasing requisite articles, gifts of clothing (which, if used, must be in good condition), and recent chemical literature, will be welcome. The Chemical Society will continue to act as the receiving depot, and cheques (made payable to Mr. S. E. Carr, and crossed "Russian Fund"), together with parcels of clothing, boots, books, etc., should be addressed to the Assistant Secretary, The Chemical Society, Burlington House, Piccadilly, W.1.

Yours faithfully,
JAMES WALKER,
President.

BRITISH ASSOCIATION.

FUEL ECONOMY.

(*Continued from Page* 188.)

Present Tendencies in the Use of Oil Fuel.—Before the advent of the internal combustion engine, the term "fuel oil" was restricted to an oil intended to be burnt in furnaces and the like. In the early days of oil fuel practice, comparatively light oils were used. They were "atomised" and injected into the boiler furnace or the like by means of steam or air, and the burners used were often of a crude and unsatisfactory character. In recent years, however, more attention has been given to the proper design of such burners, and to the more effective combustion of the fuel oil. The consumption of air or steam by the oil burners has been considerably reduced, and, as they have attained a higher degree of mechanical

efficiency, heavier oils have been successfully used in them. Methods have now been devised whereby heavy oils may be sprayed into the furnace under pressure alone, without the aid of either steam or air; and, therefore, it has become possible for heavy petroleum residues, such as asphaltum, to be employed as first-class fuels for land installations. A similar tendency has recently been manifested in the use of fuel oil in internal combustion engines. Until very recently petroleum refiners prepared a very light fuel oil for these engines, but mechanical research is now being directed in order to render them capable of burning even the heaviest oils. Progress in this direction has been greatly helped by scientific investigations upon the spontaneous ignition temperatures of fuel oils. The outstanding question to-day is how to adapt a heavy fuel oil for use in low compression internal combustion engines; this is now receiving the close attention of scientific investigators, and it may be hoped that as a result of their work the public will in due course be enabled to use heavy fuel oil in the place of motor spirit.

III.—The Chemistry of Coal.

Progress towards the solution of the problem of the constitution of coal substance can be recorded, notwithstanding the magnitude and complexity of the problem. The difficulties arise in no small measure from the absence from the products of such researches of bodies with crystalline habit or other well-defined physical characters by which the chemist is accustomed to identify the compounds he isolates. Still, the literature shows the subject has attractions for not a few chemists who, employing various methods of attack, seek to obtain information as to the nature of the multifarious compounds which go to the make-up of coal. As, however, different investigators select for their study coals of varying origin and of different classes, it is not always easy to compare the results obtained.

The work of Clark and Wheeler (*Trans. Chem. Soc.*, 1913, 103, p. 1704), combining the application of solvents with the study of the action of heat upon the extracts of the coal so obtained, has undoubtedly given much useful and valuable information. The results, however, still leave open to conjecture and theoretical explanation the true nature of the components of the several fractions. The classification of the coal components by Clark and Wheeler based upon the pyridine-chloroform treatment is too facile; nor could it be expected to provide material for a complete explanation of the properties of coal.

The breaking down of a bituminous coal by treatment with a mixture of pyridine and amyl alcohol yields an extract from which, by successive use of ether and light petroleum, Bone, Pearson, Sinkinson, and Stockings (*Proc. Roy. Soc.*, A, vol. 100, 1922, p. 582) have succeeded in obtaining (1) a non-resinous wax-like substance, (2) a resin, to which the formula $C_{31}H_{32}O_3$ is assigned, (3) a portion, insoluble in ether, consisting of non-resinous material, partially dissolved by alcoholic potash, and this they designate as "humic substance." The authors are satisfied that these humic substances are not "resinic" but "cellulosic" in origin. The influence of these several fractions on the coking of a coal has been studied, with the result that, whereas the said resin is in part responsible, the main cause of the coking propensities was shown to be a series of substances of "humic" type which are soluble in chloroform but not in ether, and whose fusion temperatures are below those at which they undergo rapid decomposition.

The acidic substances extracted by alkalis from the aforesaid humic bodies are precipitated by acids from these solutions, as bulky, dark-coloured, opaque jellies. These jellies, on drying, form black, brittle, lustrous, and structureless masses, with conchoidal fractures, suggestive of the material forming bright coal which Stopes has styled "vitrain." The consideration of these facts has led Bone and his co-workers to suggest that "bright coal" may have originated in a colloidal gel.

In this connection attention may be directed to a like conclusion arrived at by Dr. J. A. Smythe in 1906, in a paper read before the University of Durham Philosophical Society, [3] which dealt with certain Peaty Deposits from a Pit-Fall at Tantobie, County of Durham. Amongst the substances described is a black jelly-like body, which Smythe styled "black-stuff," and this he showed by its composition and

3 *University of Durham Philosophical Society Proceedings*, Vol. 2, pt. 6.

behaviour to solvents, notably to pyridine, suggests a similar relationship to bright coal.

It has long been recognised that bituminous coals contain three easily distinguishable components, which until recently had usually been designated (*a*) "mother of coal" or "mineral charcoal," (*b*) "dull hard coal" (Ger. = "Mattkohle"), and (*c*) "bright coal" (Ger. = "Glanzkohle"), respectively, the last named being a structureless, lustrous substance with a conchoidal fracture. Recently Stopes (*Proc. Roy. Soc.*, B. 90 (1919), p. 470) proposed new names for them, namely (*a*) *fusain*, (*b*) *durain*, whilst (*c*) is termed by her either *clarian* or *vitrain*, according as it does or does not contain recognisable plant tissues and structures. In putting forward these proposals Stopes recognised that none of the four said ingredients (with the possible exception of vitrain) are either homogeneous or chemical molecular units; also that they do not even approximately represent the crystals in a petrological section of a rock. Provided that such qualifications are kept clearly in mind, and that it be realised that clarain may prove to be merely vitrain in which plant structures occur in suspension, the Committee sees no great objection to the provisional substitution of the proposed new names for the older ones, regarding the matter more as one of convenience than as involving any new principle.

The Committee also feels that the growing practice among coal-chemists to use the terms, *alpha*, *beta*, *gamma*, etc., to designate the several components obtainable from the coal substance by fractional extraction of it by means of various solvents, is one which, unless regularised in some definite way, is likely to lead to much confusion and obscurity, to the detriment of progress. It is obvious that coal may be "fractionated" in as many different ways as there are suitable solvents and modes of applying them; and therefore unless, as the results of some particular treatment or procedure, components of a reasonable degree of purity and well-defined properties are isolated, it is undesirable that definite names should be assigned to them, as though they were the actual chemical constituents of the coal instead of unknown mixtures of them. The Committee, therefore, would suggest that the time has come when chemists should agree in conference upon some common plan of labelling such "coal fractions" which, whilst recognising them to be such, shall also in some way indicate how they have been obtained.

Supposing, for example, that a particular investigator extracts a coal with two solvents A and B, he might designate the fraction which is insoluble in both as the α AB fraction, whilst β AB might be used to denote the fraction which is soluble in A but not in B, and the γ AB that which is soluble in both A and B, assuming all solvents to be used at their respective boiling points at atmospheric pressure. Thus, a fraction termed the "*α pyridine-chloroform*" fraction would mean the residual insoluble portion of a coal after successively extracting it with pyridine and chloroform at their respective boiling points; the "*β pyridine-chloroform*" *fraction would be that* portion of the pyridine extract which is insoluble in chloroform; whilst the "*γ pyridine-chloroform*" fraction would mean the portion of the coal which is soluble in both pyridine and chloroform, and so on. In cases where the coal is extracted at some particular temperature other than the boiling point at atmospheric pressure of the solvent employed, the actual temperature employed might be designated by putting it in small type above the name of the solvent, thus, "-benzene ^{120}," denoting that benzene had been used at 120° C.

IV.—BROWN COALS AND LIGNITES.

Although Great Britain itself is almost destitute of sub-bituminous coals and lignites (the Bovey Tracey deposit in Devonshire being the only important one in this country), the problem of using them efficiently is of great importance to several of the Dominions, and especially so to Australia, Canada, and India. Of the total estimated Canadian reserves, amounting altogether to 1,234,268 million tons, no less than 1,072,627 million tons are of a sub-bituminous lignitic class occurring in the upper cretaceous formations of the province of Alberta, whilst in the neighbouring province of Saskatchewan there are both cretaceous and tertiary lignite reserves amounting to 59,182 million tons. The Dominion Government has set up a Lignite Utilisation Board for the purpose of investigating the best means of utilising these resources, and it is hoped that the approaching meeting of the Association at Toronto in 1924 will afford an opportunity of discussing the problem in all its bearings.

In Australia, the provincial Governments of Victoria, South Australia, and New South Wales are all interesting themselves in the utilisation of their brown coal and lignite resources. Of these, the celebrated Morwell deposits in the Gippsand district of Victoria, which are of phenomenal thickness without parallel elsewhere in the world, are of great scientific interest, as well as of economic importance for the future of Australia. It has been estimated that within an area of 50 square miles in the Latrobe Valley, and within 1,000 ft. of the surface, there are 31,144 million tons of the coal. A bore-hole put down near Morwell disclosed no fewer than seven beds of brown coal within 1,000 ft. of the surface, of a total thickness of 781 ft., the individual seams (taken in order from the surface) running 29 ft. 8 in., 25 ft. 8 in., 23 ft., 227 ft. 10 in., 265 ft. 6 in., 166 ft., and 43 ft. 8 in. respectively. So far as they have been examined, they were reported by the Victorian Advisory Committee on Brown Coal, in 1917, as consisting of "a matrix of earthy brown coal, with sporadic inclusions of lignite . . . the matrix consists of pollen grains, spore cases, and decomposed vegetable matter. . . . The coal varies in colour between yellowish brown and black, but it always pulverises to brown powder." The raw coal usually contains about 50 per cent. of water; the *dry* coal contains: Carbon = 62.5, Hydrogen = 4.85, Nitrogen = 0.45, Sulphur = 0.20, Oxygen = 28.00, and Ash = 4.00 per cent. Its gross calorific value is about 5,600 K.C.Us. per kilogram.

In the year 1917 the Advisory Committee appointed by the Victorian Government to investigate the possibilities of generating electric power on a large scale from the Morwell coal reported that, notwithstanding its low grade, power could be more cheaply generated from it for the City of Melbourne than from black coal imported from New South Wales. It has been officially estimated that the cost of producing raw Morwell coal at the mines will not exceed 2s. 6d. per ton. The Victorian Government has already authorised the expenditure of £6,000,000 upon the development of the Morwell coal deposits in the expectation that by the year 1924 electrical energy from thence will be supplied, not only to the City of Melbourne, but also throughout the whole State of Victoria. It has been calculated that the cost of such energy at the mine will be as low as £2 17s. 6d. per horse-power per annum, and that it can be sold profitably to manufacturers throughout the State at an average price of £4 8s. per horse-power per annum. Large-scale steam trials are, or have been, in progress with a view to ascertaining how the coal may best be burnt under boilers, and a large electric power-station scheme at Morwell is rapidly materialising, and a large order for water-tube boilers in connection therewith has recently been placed in this country.

The problem of how such low-grade fuel as brown coals and lignites can be most efficiently burnt in boilers has therefore become one of great importance. It is obvious that a prime condition of efficient combustion is that coal shall be dried before being burnt; and as this drying can be effected at the expense of some of the sensible heat in the waste gases from the boiler, provided that they contain nothing less than 10 per cent. of carbon dioxide, such a drying operation may be cheaply carried out as an integral part of the boiler operation. Whether or not, as an addition to such drying operation, the coal should be subjected to a preliminary low-temperature carbonisation, using the residue therefrom as the boiler fuel, is a matter for future investigation to decide. In this connection attention may be drawn to the recent discovery made bp Bone (*Proc. Roy. Soc.*, A, vol. 99, 1921) whilst investigating Morwell brown coal, Saskatchewan and other typical lignites:—

(*a*) that there is for each particular brown coal or lignite a certain definite temperature limit (usually between 300° C. and 400° C.) up to which it may be heated (in the *dry* state) so as to effect considerable chemical condensation in its cellulosic or humic constituents, with simultaneous expulsion therefrom of steam and carbon dioxide, together with a small but variable proportion of carbonic oxide; and that such chemical condensation is unaccompanied by any other change productive of either hydrogen or hydrocarbons;

(*b*) that, by means of such condensation, substantially the whole of the potential energy of the fuel may be correspondingly concentrated by suitable heat treatment (within the prescrib

temperature limit) in the resulting carbonaceous residue, which may therefore be burnt with greater calorific intensity than the original coal; and

(c) that, accordingly, such treatment constitutes a possible means of "upgradgrading" brown coals and lignites generally, thus improving their fuel values.

RECLAIMED RUBBER.

A paper on "Reclaimed Rubber" was read by Dr. J. Torrey at a meeting of the Manchester Section of the Institution of Rubber Industry, held on Monday, Sept. 18th. Mr. H. Mandleberg presided.

Dr. Torrey said the reclaimer was at this time confronted with an unexpected and a very critical economic problem. For twenty years reclaimed rubber had played a significant part in the manufacture of rubber goods in Great Britain. Economic conditions had now reduced enormously the amounts used, but the manufacturers who had been purchasers were not indifferent to the changed conditions, and it was fitting that the reclaimer should suggest how the relation which had hitherto existed between the manufacturers and the reclaimers should be conserved.

Circumstances had made the United States the foremost reclaimers and users of reclaimed rubber in the world. The grades of scrap rubber handled were few in number. From the start the tendency had been to put on the market a few standard reclaimed rubbers, each representing a product reclaimed from a definite grade of scrap. There was very little blending or mixing. The output was large, and the long uninterrupted runs on the same grade of scrap made for low manufacturing cost and uniform quality. In Great Britain the reclaiming industry had a totally different history. There had been no standardisation; the whole tendency was towards individualisation. One company had in its formula books a hundred separate and distinct reclaimed rubbers, and the analysis of any month's sales would show 38 to 42 grades. The reason for this strong individualisation was that reclaimed rubbers were additions, and must fit in with other ingredients, which usually meant the concocting of a special stock. A day's run often consisted of from five to even eight or ten stocks, and [illegible] the quantities of each were not large. This tended to increase manufacturing costs, and made it more difficult to attain uniform quality.

What was required now was a method capable of dealing with scrap rubbers containing cotton fabric. The chemicals used must be cheap and abundant, the processes continuous, the machinery simple, necessary labour reduced to a minimum. The question of separating and recovering the cotton as well as the rubber substance had always been in the minds of reclaimers, but there had been good and sufficient reasons why it had not become prominent. The rubber substance had a competitive chance in the market; the cotton certainly had not. With regard to the problem of fabric destruction, none of the solvents for cellulose had proved useful. The conditions under which satisfactory solution could be effected were too exhausting and too easily disturbed. Then again, unless the chemical was practically valueless there must be a means of recovering as much as possible to use again. The only two reagents that had proved themselves available were dilute sulphuric acid and caustic soda solution, either concentrated or dilute. The former was effective at boiling point under ordinary atmospheric pressure, but the caustic soda process required closed vessels and fairly high temperatures, usually about 360° F. Both processes were effective and simple. The free sulphur which the scrap rubber contained must be removed if present in ordinary quantities, and this was accomplished by the alkali process at the same time that it destroyed the fabric. The acid process did not do this; therefore it must be supplemented by an alkali treatment to remove the free sulphur, or a scrap must be employed which contained very little free sulphur. Usually the second alternative was adopted, and the most suitable scrap was rubber shoes. It was doubtful whether a finer, all-round reclaimed rubber had ever been produced than the high-class American shoe stocks and the equally useful Russian shoe stocks which were so prominent in pre-war times. The only American reclaimed rubbers that had ever gained a real foothold in this country were those shoe stocks.

In America reclaimed rubber was the staple material in many classes of goods; other substances, such as rubber, minerals, oils, etc., were added to it. In Great Britain the reclaimed rubber was itself an

addition only, and must fit in with the other substances to produce the desired results as to cost and quality. This made the task of the reclaimer a difficult one, but nevertheless reclaimed rubber made steady headway and won a place for itself. The fluctuations in the price of raw rubber had little effect on the demand, and the prices quoted and paid for reclaimed remained practically constant, while raw rubber fluctuated from 2s. 6d. to 10s. per lb. Now all was different. To-day the best crepe could be bought at about 7½d. per lb. What inducement then was there to use reclaimed rubber? It was steadier in price and quality than plantation rubber. It was an effective and safe accelerator of vulcanisation. It was almost impossible to injure it on the mill. It was valuable in tubing machine work. Time was saved in the milling and the vulcanisation. Labour was saved, especially if each class of reclaim went into the kind of goods from which it was reclaimed. If manufacturers resumed the use of it in anything like a whole-hearted way, it would be because it was cheaper to use, and the goods required were produced with less trouble and with less expenditure of time, care, and labour. But this argument was not accomplishing much now, and years might pass before the effect was really significant. Meanwhile the reclaimer could not go on indefinitely catering to a fragmentary and sporadic business. There was no sign of any decided rise in the price of rubber, and the chances were not good of being able to reduce the cost of the reclaimed rubber by the recovery and utilisation of the cotton mixed with the rubber substance. There remained the probability of some new and extensive line of manufacture, such as rubber tiles or blocks for roadways, flooring and roofing. Here the wearing and weather resisting powers of reclaimed rubber would come in, and the labour saving would count very decidedly. It was difficult, however, to see any solution of the problem without some decided change in the general business situation. Most of the grades of scrap rubber were to-day not worth the cost of collection and transportation; much less were they worth reclaiming.

THE CONSTITUTION OF ALUMINATES.

By Jaroslav Heyrovsky, D.Sc. (Lond.), Ph.D. (Prague).

The acidity of aluminium hydroxide is greater than it might appear from ordinary analytical experience. For the determination of its acidic strength, however, the precipitated hydroxide must not be used, since it "ages" quickly, *i.e.*, loses reactivity besides occluding other matter. The alkaline solutions show the highest and definite degree of neutralisation in which aluminium hydroxide reacts in the "nascent state," being just formed by the action of the solution on metallic, preferably amalgamated aluminium. Thus solutions of aluminates result, which are, in the absence of carbon dioxide, at the room temperature and decinormal dilution not more than 1.5 per cent. hydrolysed.

From the physico-chemical investigations of such solutions it is obvious that aluminium hydroxide reacts as a typically mono-basic acid, being similar in this respect to boric or arsenious acid (compare *Trans. Chem. Soc.*, 1920, CXVII., 1013, and *Rozpravy České Akademie*, 1921, XXX., No. 27).

In order to investigate the monobasicity of the "aluminic acid" further, the researches were extended to the solutions of alkaline earths (*Bulletin de l' Academie des Sciences de Bohême*, 1922, No. 25, by J. Heyrovsky, H. Kadlcová, and K. Stoklasová). The cryoscopic method of Noyes and Whitney (*Zeitsch. Phys. Chem.*, 1894, XV., 693) was used, and in some cases conductivity measurements and analysis of the solutions were studied.

Magnesium and Calcium.

The aluminates of these metals are only slightly soluble. Into a saturated solution of magnesium oxide (*Kahlbaum's puriss.*) of specific conductivity 1.11×10^{-4} mho. (at 25° C.), amalgamated aluminium foil was dropped. After the dissolution, the conductivity decreased to 0.273×10^{-4} mho., and remained constant, showing that the solubility of magnesium aluminate is about one-third of that of the hydroxide.

Similarly, a solution of pure calcium oxide of specific conductivity 8.30×10^{-3} mho. (at 25° C.) showed after the dissolution of aluminium a decrease to 1.90×10^{-3} mho.; simultaneously white foils of the calcium aluminate separated out.

The cryoscopic examination *of a lime* solution showed 0.087° C. lowering; after the dissolution of aluminium this decreased to 0.028° C. Thus the solubility of calcium aluminate appears to be one-third of *that of lime.*

STRONTIUM.

In a 0.057 normal strontium hydroxide solution, small pieces of aluminium foil were dissolved, and after each dissolution the lowering of freezing point was observed. The results were as follows:—

gram-atoms Al. dissolved per litre.	lowering of freezing point observed.
0.	0.159° C.
0.005	0.170
0.011	0.175
0.050	0.172
0.056	0.176

After several weeks the solution was analysed, and the atomic ratio of Al : Sr found as 0.90 : 1.

BARIUM.

A 0.0605 normal solution of barium hydroxide was gradually saturated with aluminium, and corresponding conductivity changes and cryoscopic readings were observed. The results are:—

gram-atoms Al. dissolved per litre.	specific conductivity at 0° C.	lowering of freezing point.
0.	6.745 10 mho.	0.119° C
0.0206	4.855	0.120
0.0313	3.927	0.120
0.0428	2.909	0.120
0.0626	1.880	0.120
0.0759 (decomposes)	4.137	0.125

The *decrease of conductivity with* increasing aluminium contents is quite regular and linear until the atomic ratio of Al : Ba is 2 : 1, which indicates that no other ions than monovalent anions substitute the hydroxyl ions in neutralisation.

After the spontaneous decomposition of the *fully saturated solution, the* conductivity reached the same value as has been observed in the half-saturated solution, containing one atom of aluminium to one atom of barium; hence the hydrolysis in this final solution is 50 per cent.

Another set of measurements was made with a 0.186 normal baryta solution. Here the lowering of freezing point was 0.380° C., and gradually changed to 0.363° in the solution, which was most saturated with aluminium hydroxide. Analysis of this solution gave, after several weeks' standing, the ratio of atoms of Al: Ba as 0.97 : 1.

CONCLUSIONS.

The slight changes in the lowering of freezing points and the regular fall of conductivity observed in solutions of alkalies as well as alkaline earths, when gradually saturated with aluminium hydroxide in the nascent condition show that in dilute solutions (below decinormal) only monovalent aluminate ions exist. In contact with *crystalline aluminium hydroxide all these* solutions are about 50 per cent. hydrolysed, with nascent aluminium hydroxide the hydrolysis is only 1—1.5 per cent.

The process by which aluminium hydroxide dissolves in alkalies is undoubtedly that suggested by Pfeiffer, viz., complex-anion formation:—

$$Al(OH)_3 + OH' \rightarrow Al(OH)_4'.$$

(*Ber.*, 1907, XC., 4036.)

From this point of view aluminium hydroxide is not an acid, which could neutralise an *alkaline solution by its hydrions*; it removes hydroxyl ions by forming complex anions with them just as other compounds do, when redissolving in excess of reagents, *e.g.*, $Ag(CN)_2'$, HgI_4''. It neutralises not by its acidity but by its affinity for hydroxyl ions. The hydrolysis of aluminates is then not effected by the scarcity of hydrions due to "aluminic acid," but by the incompleteness of the complex formation.

The explanation given in analytical textbooks as if *aluminium hydroxide could* send into solution one, two or three of its hydrogen atoms as ions, and thus to react in a manner analogous, say, to phosphoric acid, does not agree with the experimental evidence mentioned in this paper, and ought to be rejected.

Since 4 and 6 are the co-ordination numbers of aluminium, its complex anions are of the type AlX_4' and AlX_6'''; this would not exclude the possibility of aluminate ions $Al(OH)_6'''$ in most concentrated solutions. Experimentally, in dilute solutions, only Al $(OH)_4'$ ions were detected.

The Chemical Department of the Charles' University, Prague.
September 25, 1922.

BRITISH ASSOCIATION.

(SECTION K—BOTANY.)

TRANSPORT OF ORGANIC SUBSTANCES IN PLANTS.

ADDRESS BY PROFESSOR H. H. DIXON, Sc.D., F.R.S., *PRESIDENT OF THE SECTION*.

Plant physiologists have not paid the attention to the transport of organic substances which the importance of the subject appears to deserve. The ascent of water in high trees in defiance of gravity strikes the casual observer and forces him to speculation as to how it is contrived; but the problem of the transmission of organic substances throughout plants only forces itself on those who are more or less conversant with some of the leading facts of vegetable physiology.

Among physiologists the usually accepted view is that organic substances are distributed throughout the plant by means of the bast. The wood also acts as a channel of distribution for these substances to opening buds and developing leaves, especially in spring when root-pressure is active. The sap of bleeding contains appreciable quantities of these substances, and their distribution to the developing buds in spring by means of the wood was recognised by Hartig and Sachs. Fischer showed that even in summer many woody plants contain reducing sugars in their wood. The sugar content of the wood is at a maximum in spring, diminishes in summer, and is at a minimum in winter; at the end of February it rises rapidly. There is a second crest on the curve at leaf-fall. Dr. Atkins and myself extended Fischer's observations, and showed that appreciable quantities of soluble carbohydrates, sucrose, hexoses, and even maltose, are found in the tracheæ of the stems and roots of many trees at all seasons of the year. Being in the tracheæ they must be carried from the lower parts to the upper growing regions, including the cambium of the stem. Samples drawn from different levels during the spring were found to have a greater concentration at higher levels. The inflow of water below, and consequent dilution, is probably largely responsible for this difference. Towards the end of the season there is no marked difference.

This upward transport of carbohydrates in the tracheæ seems to be accompanied with smaller amounts of proteins. Thus Schroeder showed that the quantity of proteins in the bleeding sap rises and falls with the quantity of sugar.

This view that the rising current in the tracheæ carries organic substances in it and distributes them to the growing regions has lately been impugned. It was pointed out that in many cases ringing close below the terminal bud prevents the development of that bud because the wood is unable to transmit sufficient supplies of organic substance. As Strasburger has already pointed out, this interpretation rests upon the fallacy of supposing that the removal of the bark as far as the cambium leaves the wood uninjured. As a matter of fact, microscopic examination of the wood, from which the outer tissues have been stripped, shows that its tracheæ soon become blocked with air-bubbles and with substances probably exuded into them and their walls during morbid changes in the cells of the cambium, in the cells of the medullary rays, and in those of the wood-parenchyma. The blocking is accompanied with discoloration, and is most apparent in the outer layers of the wood. It is only reasonable to suppose that the efficiency of the tracheæ as channels of transmission is seriously impaired even before there is visible evidence of plugging.

It is evident that this clogging may act differentially on the water and the substances it carries in it. In the first place, the whole cross-section of the wood is available for the transport of water, while probably the outer layers are mainly utilised by the organic substances. Further, colloidal deposits in the walls, and especially in the pit-membranes, would obstruct the passage of organic substances much more than they would the water which carries them. These considerations readily explain how it is that, while the water-supply to the buds of ringed branches is adequate, the supply of organic substance may be deficient.

Apart, then, from the very slow movement of organic substances from cell to cell, there is very cogent evidence that their upward motion is effected in the tracheæ of the wood. There is no reason to believe that during this transport the walls or pit-membranes of these tracheæ oppose the passage of the dissolved carbohydrates or of the simpler proteins any more than the water which conveys them. Hence the velocity of transport of these organic substances is that of the transpiration current, and the amount conveyed in a given time depends on the velocity and concentration of the stream.

The transport of organic substances in an upward direction in plants is secondary, for, as is well known, carbohydrates certainly, and proteins most probably, are manufactured only in the upper green parts of plants—principally in the leaves, and must be transported in the first instance back from these to the stems to be distributed to the growing regions and to the storage organs.

It is almost universally held that the channel for this backward or downward motion of organic substances from the assimilating organs is the bast of the conducting tracts. The orthodox position is summed up by Strasburger as follows: In woody plants the carbohydrates manufactured by the leaves pass downwards in the bast. Movements of carbohydrates in the opposite direction in this tissue only take place if they are occasioned by local consumption. From the bast the carbohydrates spread into the medullary rays and wood-parenchyma, and in young branches fill these tissues and more or less of the pith. A downward movement in the wood-parenchyma, such as was formerly held, does not take place, and in those conifers in which there is no continuous wood-parenchyma is anatomically impossible. In spring and also during summer-growth an upward transport of carbohydrates in the water tracts occurs

This view that the channel for the backward and downward movement of organic substances is afforded by the bast received great support from Czapek's work published in 1897. By section of the conducting tracts in one half of the petiole he showed that depletion of the corresponding half of the blade was delayed. He also showed that only where vertical bridges connected the upper and lower portions of bark in ringed stems were the effects of ringing nullified. Oblique and zigzag bridges are ineffective. Thus transverse conveyance in the stem is negligible. The parallel and longitudinal arrangement of the elongated elements in the bast seemed to him to provide adequately for the observed longitudinal passage. Their narrowness and large colloid content did not present themselves as difficulties.

He also recorded the observation that the blades of leaves, the petioles of which had been killed by jacketing them with steam, did not become emptied of starch. Similarly, when the petioles were killed with chloroform-vapour, depletion was arrested. Again, anæsthetisation of the petiole, by surrounding it with a watery solution of chloroform, greatly delayed the disappearance of starch. On the other hand, depletion was not obstructed when the petiole was immersed in a 5 per cent. solution of potassium nitrate. From this last observation he concluded that plasmolysis of the translocating elements does not interfere with their function as channels of transport.

Czapek formed no definite theory as to how organic substances were moved in the past. He was sure that the transport depends on living protoplasm. He did not consider that the streaming of protoplasm contributed materially to the motion, seeing that streaming does not occur in mature sieve-tubes. He regarded the sieve-tubes as the most important elements in the transmission of these substances, because the deposition of callus in the sieve-plates synchronises with the stoppage of transport. The transport, according to him, is not simply due to diffusion. He supposed the protoplasm to take up the organic substances and pass them on. If diffusion does not account for the passage from one particle of protoplasm to the next, it would seem that we must suppose the organic substance to be projected from one to the other.

These observations and their interpretation by Czapek have strengthened the opinion that the bast is the channel for the downward transport of organic substances. It is remarkable how little weight has been attached to the damaging criticism of Czapek's views by Deleano, especially as those views are so unsatisfactory from a physical standpoint.

The latter author showed that it is inadmissible to compare externally similar leaves, which often behave, so far as de-

pletion is concerned, very dissimilarly. He also pointed out that without any export a leaf may be depleted of all its starch within thirty-five hours, and partially anticipated an extremely interesting recent observation of Molisch—namely, that transpiring leaves lose their carbohydrates much more rapidly than those whose transpiration is checked by being surrounded with a saturated atmosphere. Neglect of these facts led Czapek into error. Deleano also showed that organic substances continue to leave the blades even after the petioles have been killed by heat or by chloroform-vapour. The rate of depletion is reduced by the former agent to about one-third, and by the latter to one-half. If this observation is substantiated it would show that the intervention of living elements is not essential for the transport. He further found that the blades attached to petioles which were surrounded by chloroform-water lost their starch more quickly than those immersed in water.

The contradictory conclusions of Czapek and Deleano urgently call for a reinvestigation of the points at issue. It is not enough to assume, as Schroeder does, a completely sceptical attitude towards the latter investigator's account of his experiments. If Czapek's work holds good, we will have to regard the bast, and especially the sieve-tubes, as the channels for the transport of organic substances back from the leaf-blades where they are manufactured, and we must look for some hitherto undreamed-of method of transmission through these most unlikely-looking conduits. On the other hand, if Deleano's conclusions are borne out, we should admit that protoplasm is not necessary for the transport, and we would turn to a dead tissue as furnishing this channel.

So far as I am aware none of the earlier investigators made any estimate either of the actual quantities of organic material which are transported or of the velocities of flow in the channels which are necessary to effect this transport.

We may approach this problem from two opposite directions—(1) by dealing with the amount of organic substance accumulated in a given time in a storage organ, or (2) by using the amount exported from an assimilating organ. The cross-section of the supposed channels of transport and the volume of the solution containing the substances in each case will give us the other necessary data.

For the first method a potato-tuber will furnish an example. One weighing 210g. was found attached to the base of a plant by a slender branch about 0.16 cm. in diameter. In this branch the bast had a total cross-section of 0.0042 cm.2. This figure is a maximum; no allowance was made for the cross-section of the cell-walls, or for any non-functional elements in the bast. Now if the bast exclusively furnished the channel of downward transport, all the organic substance in the potato must have passed this cross-section during the time occupied in the growth of the potato. One hundred days would be a liberal allowance. According to analyses more than 24 per cent. by weight of the potato is combustible. Therefore we must assume that during this time more than 50g. of carbohydrate has passed down a conduit having a cross-section of no more than 0.0042cm.2. The average concentration of the solution carrying this substance could scarcely have been as much as 10 per cent. (2.5-5 per cent. would be more probable. The concentration of sugar in bleeding sap is much below this figure, and seems never to reach 4 per cent.). Assuming, however, this concentration, the volume of liquid conveying 50g. must have been 500cm.3, and this quantity must have passed in 100 days. Therefore the average velocity of flow through this conduit, having a cross-section of 0.0042cm.2,

must have been $\frac{500}{0.0042 \times 100 \times 24}$, *i.e.*, nearly 50 cm. per hour.

By the second method we arrive at a different figure. Various investigators, from Sachs onwards, have measured the rate of photo-synthesis per square metre of leaf per hour. Under the most favourable conditions the amount may approach 2g., and it has been estimated as low as 0.5g. Taking Brown and Morris' determination for *Tropæolum majus*, viz., 1g. per square

metre per hour, and assuming one-third of the carbohydrate formed is used in respiration in the leaf, we find that a leaf of 46cm. may form during ten hours' sunshine 0.46g.; during the twenty-four hours one-third of this will be respired, leaving 0.31g. to be transported from the leaf. The volume of the solution (again assuming a concentration of 10 per cent.) will be $3.10cm.^3$.* The cross-section of the bast of the bundles in the petiole was $0.0009cm.^2$, therefore the velocity of flow, if the bast was used as the channel of transport, must have been $\frac{3.10}{0.0009 \times 24}$ or 140 cm. per hour.

Similar figures to these were derived using measurements obtained from a number of potato-tubers and from various leaves. The velocities indicated, even assuming a concentration of 10 per cent., lay in all cases between 20 cm. and 140 cm. per hour. These figures are in agreement with those arrived at by Luise Birch-Hirschfeld, as to the weight of organic material transported from leaves.

A flow of this rate through the bast seems quite impossible. The narrow transverse section of its elements, the frequent occurrence of transverse walls, and the lining of protoplasm and large protein contents practically preclude the mass movement of liquid through this tissue. If we imagine the flow restricted to the sieve tubes the velocity must be correspondingly increased, and the excessively fine sieve-pores, more or less completely occupied by colloidal proteins, must be reckoned with. Simple diffusion, as Czapek recognised, cannot account for the transport, and there is no reason to suppose that adsorption on the surfaces of the colloid contents of the sieve-tubes can increase the velocity of diffusion, as Manghan suggests.

As soon as one realises the volume of the solution which has to be transported, and the velocity of the flow that this necessitates, one naturally turns to consider if the open capillary tubes of the wood may not be utilised as channels of transport. Deleano's results, indicating that the depletion of leaves continues even after the living elements of their petioles have been killed, support this conjecture.

The emphasis which has been laid on the function of the wood as providing a channel for the upward movement of water usually obscures its function as a downward and backward channel also. Early experimenters, however, fully recognised that, under certain conditions, the current in the wood may be reversed. Thus Hales quotes several experiments of his own proving this point, and states that some of his were but repetitions of Perault's earlier work. In these experiments Hales showed that water applied at the top of a branch, which is severed from the tree, is drawn back into the branch and supplies its leaves, and makes good their transpiration losses. A tree inarched into two adjacent trees may continue to grow even after its connection with the ground is severed, drawing its supplies from its neighbours. Finally, a forked branch removed from a tree will remain fresh, and continue to transpire water for many days if one limb of the fork with its leaves is immersed in water. There is, of course, recent work also showing this reversed current.

By means of an eosin solution this reversal of the transpiration current may be very easily demonstrated. If the tip of a leaf of a growing potato-plant is cut under eosin solution, the coloured solution is very quickly drawn back into the tracheæ of the conducting tracts of the leaf; from there it passes into those of the petiole, and makes its way not only into the upper branches and leaves, but also passing down the supporting stem may completely inject the tracheæ of the tuber, and from thence pass up into the wood of the remaining haulms of the plant. Its passage is entirely in the tracheæ of the wood of the conducting tracts.

Another very striking experiment may be carried out with the imparipinnate leaf of *Sambucus nigra*. Its petiole is split longitudinally for a few centimetres and half removed. The remaining half is set in a solution of eosin. The solution is rapidly drawn up the wood-capillaries of the intact half-petiole, and soon appears in the veins of the pinnæ on the same side of the leaf, beginning with the lowest, and gradually working up into the upper ones. Finally it appears in the terminal pinna. All this while the veins of the pinnæ on the other side remain uncoloured. Now, however, the eosin begins to debouch into the base of the uppermost of these pinnæ and spreads through its veins; finally it makes its way down the offside of the rachis to the basis of the lower pinnæ, and from thence spreads into their veins. In this case we

see very clearly how transpiration actuates an upward current on one side and a downward current on the other. It is interesting to note that if the terminal pinna and its stalk is removed the eosin does not appear in the pinnæ of the second side, or only after a considerable time when the small anastomosing conducting tracts are utilised.

Luise Birch-Hirschfeld recently also describes many experiments with herbaceous and woody plants, tracing the path of the reversed current by means of lithium nitrate and eosin.

In all these cases the tension of the sap determines the flow from a source wherever situated, and transpiration from the leaves, or parts of leaves, which are not supplied with liquid water from without draws the water through the plant along the channels of least resistance. Hence it is that if the cut vein of a lateral pinna provides the point of entry, the solution may pass backwards in some of the conducting tracheæ, leaving others quite uncoloured, so that some of the veins only of the pinna are injected. The injected tracts bring the solution down the rachis and petiole into the stem, while a few or many, as the case may be, remain filled with colourless liquid, presumaply the sap drawn upward to supply the transpiring surfaces of the leaf. Generally the coloured liquid descends an appreciable distance in the tracheæ of the stem before it begins to rise in the ascending current, mounting to other transpiring leaves. As a rule after some time—depending on the rate of transpiration and the amount of water supplied by the roots—the presence of the coloured liquid may be demonstrated in certain continuous series, or filaments of tracheæ in several bundles of the lower parts of the stems. Similarly, if tubers or rhizomes are present examination of these parts, after a suitable interval, will show that many of their filaments of tracheæ are injected. Meanwhile the parts above the supplying leaf become coloured, and it will be seen that the distribution of coloured tracheæ is decided by the anatomical connections of those filaments of tracheæ which directly convey the coloured liquid from the point of supply through the petiole to the stem. In tracing the path of the solution one is impressed with the fact that the path of least resistance is by no means always the shortest path in the wood. Transverse motion across several tracheæ seldom occurs, and the separate linear series of conducting tracheæ are practically isolated from each other laterally. Here we may recall Strasburger's experiments showing the very great resistance offered to the flow of water in a transverse direction in the wood of trees. This isolation of the separate filaments of tracheæ in the leaf and in the stem enables the tension developed by the transpiring cells of the leaves, while it raises a column of water in one series of tracheæ, to draw down a solution in a neighbouring filament of tracheæ terminating above in some local supply. If the anatomical connection of the two series is located in a subterranean organ the tracheæ of the subterranean organ may become filled from that supply.

So far the evidence of reversed flow in the water-conducting tracts which we have been considering has been derived from plants under artificial conditions—plants whose conducting tracts have been cut into and otherwise interfered with. Is there any evidence that reversal of the transpiration-current normally occurs in uninjured plants?

Some recent work on the transmission of stimuli seems to me to indicate that these reversals are continually occuring in normally growing plants.

The first piece of work to which I would direct your attention is that of Ricca on Mimosa. It has long been known that the stimulus which causes the folding of the pinnules and the bending of the petioles of Mimosa could traverse portions of the petioles or stems which had been raised to such a temperature as would kill the living elements in these organs. Notwithstanding that observation, Haberlandt's view, that the stimulus is transmitted as a wave of pressure through certain tubular elements of the bast, was generally accepted as the least objectionable of any of the theories which had been put forward to explain this transmission. Ricca saw that, among other difficulties, the slowness of transmission—never more than 15mm. per second—was a grave objection to this view. Accordingly, working with a woody species of Mimosa—*Mimosa Spegazzinii*—he removed the whole bast and outer tissues of the stem for many centimetres — viz., twenty-three — and was able to show that the stimulus was still transmitted. Similarly he found that the stimulus was transmitted through narrow strips of the wood

from which even the pith had been removed. These experiments and others in which the transmitting organ had been killed for a considerable length caused Ricca to recognise that the stimulus is transmitted in the wood and not in the bast, as had been previously held. Thus he was led to assign the transmission to the transpiration-current. He was able to confirm this conjecture by showing that the transmission to the various leaves of a plant is largely controlled by the rate of the transpiration from the individual leaves. Thus, other things being equal, a rapidly transpiring leaf receives the stimulus sooner than a sluggishly transpiring one equidistant from the point of stimulation. He further was able to show that the stimulus may be transmitted through a glass tube filled with water, just as it is transmitted through a dead portion of the stem. Evidently a hormone set free into the transpiration-stream is the long-sought-for mechanism by which the stimulus is transmitted throughout Mimosa.

(*To be continued.*)

GENERAL NOTES.

INTERVIEWS WITH HIS MAJESTY'S TRADE COMMISSIONER AT CAPETOWN.

Major G. Fetherston, D.S.O., M.C., His Majesty's Trade Commissioner at Capetown, is in attendance at the Department of Overseas Trade for a brief period, and will be pleased to interview manufacturers and merchants interested in trade with South Africa. Appointments with Major Fetherston can be made by application to the Comptroller-General, Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. The reference, 3032/T.G. should be quoted in all cases.

GERMAN GLASS INSTRUMENT INDUSTRY.

According to the *Berliner Tageblatt*, a community of interests contract has been concluded between the Union of German Factories for Glass Instruments, in Ilmenau, and the Union of Thermometer and Glass Instrument Factories, in Roda. An arrangement has been made with the glassworks Schott und Genossen, in Jena, Gustav Fischer, in Ilmenau, and Greiner and Friedrich, in Stutzerbach, that the glass tubes manufactured by these factories shall only be sold to the firms belonging to both Unions.

BOARD OF TRADE ANNOUNCEMENT.

DISTRIBUTION OF REPARATION DYESTUFFS.

The Board of Trade desire to draw the attention of consumers of dyestuffs to the fact that the distribution of such quantities of dyestuffs as are obtained from Germany as Reparation is now being carried out by the British Dyestuff Corporation, Limited, which company has been appointed agent of the Board of Trade in the matter as from the 1st September, 1922, in place of the Central Importing Agency.

This change in agency has been accompanied by certain modifications of the arrangements formerly in force, which it is hoped will prove to the advantage of consumers:—(1) All prices now quoted will include delivery to purchasers' works or stores, and will not be subject to the 1 per cent. commission hitherto charged; (2) such prices will be in respect of 60 lbs., 120 lbs., or 240 lbs. packages (which will be free and not returnable), and a reduction of 1d. per lb. will be made on all purchases of 4 cwts. or upwards, whilst in the case of purchases of not less than 1 ton the standard price will be subject to a reduction of 2d. per lb. On the other hand, purchases of less than 60 lbs. will be subject to an addition ranging from 1d. per lb. in the case of 20 lb. lots to 3d. in the case of 1 lb. lots, to cover the cost of extra packing; (3) at the discretion of the British Dyestuffs Corporation 30 days' credit on all accounts may be given.

In all other respects the British Dyestuffs Corporation will act solely under the direction of the Board of Trade, and will follow the practice hitherto in force of distributing the dyestuffs under their original German denominations and as far as possible in their original packages.

Any additional quantities of dyestuffs which may be received from time to time will be reserved for a period of not less than 14 days for actual consumers, and notification of arrival will continue to be given, as hitherto, through the Colour Users' Association, though in addition lists of stocks held and current prices will be issued periodically by the British Dyestuffs Corporation. The first of such periodic lists will be available in the course of the next few weeks. At the expiry of the period referred to above, during which dyestuffs are reserved for consumers, they will be available to the trade generally.

Prices will continue to be fixed by the Board of Trade, and will be reviewed from time to time in accordance with general market conditions.

All enquiries on the subject should, in the first place, be addressed to the British Dyestuffs Corporation, Limited, Reparation Department, 70, Spring Gardens, Manchester.

CORRESPONDENCE.

To the Editor of "The Chemical News."

Sir,—You will be interested to know that we are opening an office for the benefit of British exporters, at 37, Southampton Street, London, W.C.2.

We shall be glad to give any of your readers information regarding prospects of trade in the United States. Representing as we do, over 7,000 of the leading wholesale and importing houses in America, firms dealing exclusively in goods from foreign countries, we are in a unique position to offer this valuable service to your readers.

We take this opportunity of pointing out that this service is offered free of all cost, as it falls within the scope of our activities which are solely concerned in advancing the sale of imported commodities throughout the U.S.A.

We trust it will be to our mutual benefit for this information to be given your subscribers through the pages of your esteemed paper.

We remain,
Yours faithfully,
The American Board of Foreign Trade, Inc.

New York, September 15, 1922.

The Department of Commerce, Bureau of Standards, Washington, U.S.A., has recently placed the following pamphlets on sale:—

A new revised edition, the 2d., of Bureau of Standards Circular No. 93, entitled "United States Government Specification for Iron-Oxide and Iron-Hydroxide Paints."

This new edition supersedes Bureau of Standards Circular No. 93, 1st edition, entitled "Recommended Specification for Iron-Oxide and Iron-Hydroxide Paints."

The specification as given in the revised edition just issued was adopted by the Federal Specifications Board as Standard Specification No. 13.

Circular No. 82, entitled "United States Government Specification for Linseed Oil, Raw, Refined, and Boiled."

This new edition supersedes Bureau of Standards Circular No. 82, 1st edition, entitled "Recommended Specification for Linseed Oil, Raw, Refined, and Boiled."

The specification as given in the revised edition just issued was adopted by the Federal Specifications Board as Standard Specification No. 4.

Circular No. 91, entitled "United States Government Specification for Ocher, Dry and Paste."

This new edition supersedes Bureau of Standards Circular No. 91, 1st edition, entitled "Recommended Specification for Ocher, Dry and Paste."

The specification as given in the revised edition just issued was adopted by the Federal Specifications Board as Standard Specification No. 12.

Circular No. 111, entitled "United States Government Specification for Flat Interior Lithopone Paint, White and Light Tints."

This new edition supersedes Bureau of Standards Circular No. 111, 1st edition, entitled "Recommended Specification for Flat Interior Lithopone Paint, White and Light Tints."

The specification as given in the revised edition just issued was adopted by the Federal Specifications Board as Standard Specification No. 21.

A limited number of copies for free distribution are available. Single copies will be furnished on request to those concerned. At any time, however, copies can be purchased singly or in quantity at five cents each by addressing request and remittance direct to the "Superintendent of Documents, Government Printing Office, Washington, D.C."

We have much pleasure in publishing the appeal on behalf of Russian Men of Science that appears in this issue.

The President and officers of the Chemical Society have spared no pains to ensure the success of this very humane effort. The sum so far collected is not great, but together with gifts in kind in the way of clothing, books, etc., appear to have been very greatly appreciated.

We would like to suggest that the students at many of our technical colleges and institutions could help by making simple chemical and physical apparatus that would be useful to their hard-pressed comrades in Russia.

The writer has seen instances where classes of students were engaged nnder the direction of an instructor in fabricating apparatus in glass, wood, etc., that was afterwards either destroyed or lost.

If the heads of departments in technical colleges would take the matter up, much good work might be done. There is very little doubt of the hearty co-operation of the students.

THE CHEMICAL SOCIETY.

ORDINARY SCIENTIFIC MEETING, THURSDAY, OCTOBER 5TH, 1922, AT 8 P.M.

The following papers were read:—

Cupric tetrammine nitrite and the corrosion of copper by aqueous solutions of ammonia and of ammonium nitrate. — H. BASSETT and R. G. DURRANT.

The additive formation of four membered rings. Part I.: *The synthesis and resolution of some derivatives of tetrahydro-1:3-diazine.*—C. K. INGOLD and H. A. PIGGOTT.

"THE GENERATION AND UTILISATION OF COLD."

The Faraday Society and the British Cold Storage and Ice Association will hold a joint meeting on Monday, October 16th next, to discuss the present position of the above subject.

The meeting will be held at the Institution of Electrical Engineers, and it will be divided into three sessions, from 2.30 to 4, 4.45 to 6, and 7.45 to 10 p.m. At the first session, following a general introduction by Prof. Alfred W. Porter, F.R.S., President of the Faraday Society, the subject to be discussed will be Laboratory Methods of Liquefaction and Methods of Measuring Low Temperatures.

The opening address will be delivered by Prof. H. Kamerlingh Onnes, and Dr. Crommelin will give a description of the equipment of the Cryogenic Laboratory at Leyden. Subsequent contributors will include Prof. C. F. Jenkin and Dr. Ezer Griffiths.

The second and third sessions will be devoted to Industrial Methods of Liquefaction and Practical Applications of Low Temperatures. The general introduction to this subject will be given by Mr. K. S. (Limited), and among those who will contribute papers will be Monsieur Claude, on the Industrial Manufacture of Hydrogen by the Partial Liquefaction of Water Gas; Mr. E. A. Griffiths, who will deal with the

Murray, of the British Oxygen Company subject as it touches aeronautical work. Messrs. Liquid Air (Limited) will arrange some demonstrations during the intervals, and will also contribute information on the Heylandt System of air liquefaction and on the use of liquid oxygen in blasting.

Invitations to attend the meeting have been extended to members of the London Section of the Society of Chemical Industry and to the Physical Society of London. Others desirous of attending are invited to communicate with the Secretary of the Faraday Society, 10, Essex Street, London, W.C.2.

NOTICES OF BOOKS.

Tested Methods of Non-Ferrous Metallurgical Analysis, by SEYMOUR PILE, M.A. (CANTAB.), and REGINALD JOHNSTON. Pp. 128. London: H. F. and G. Witherby, 326, High Holborn, W.C. 1922. Price 7s. 6d. net.

In his prefatory note to this essentially practical volume, Mr. C. T. Heycock mentions that a small amount of impurity may frequently completely alter the physical properties of a metal. Hence the importance of the careful analysis of alloys, which is often a matter of difficulty, and which demands the greatest skill of an inorganic chemist.

The authors concisely describe, sometimes in the technical slang of the laboratory, the methods which their wide experience with the Midland Laboratory Guild has found the most suitable ones for the estimation of the various metals, etc.

The present writer observes that in the case of tin they advocate the use of volumetric methods, in the presence of hydrochloric acid, for the estimation of this metal. (Compare *The Chemical News*, 1920, CXXI., 173).

The book should prove of service to analysts and works' chemists, and perhaps especially to those who are called upon to carry out certain estimations which they may not have performed for some years, in which case the authors' guidance will be of considerable value. J.G.F.D.

New Patents.

THIS list is specially compiled for the *Chemical News*, by Messrs. Rayner (Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

24240—Beach, A. G. — Calculating device for chemists. Sept. 7.

24362—Germot, A.—Process for direct obtainment of metallic antimony. Sept. 8.

24410—Farbenfabriker vorm.—Process of absorbing ethylene and its homologues. Sept. 8.

24059—Leggo, A. B.—Furnace for ore, etc., roasting. Sept. 5.

24315—Price, J. W. D.—Chemical compound. Sept. 8.

24002—Thompson, W. P.—Manufacture of sulphide dye-stuffs, and processes of dyeing therewith.

Specifications Published this Week.

184825—Young, G.—Process for the production of ethers of carbohydrates

184843—Skelley, J. M.—Manufacture of ferro-tungsten and ferro-molybdenum.

184912—Turner, W. L.—Manufacture of production of carbon-free ferro-molybdenum.

184938—Wilderman, M.—Operation of processes and cells for electrolytic decomposition of alkali salts.

184948—Carteret, G.—Process of treating titanium ores containing ore.

184957—Usines Metallurgical De La.—Process for the production of basic steel.

Abstract Published this Week.

Ferric oxide; Hydrochloric Acid.—Patent No. 183323.—*A process for obtaining Red iron oxide* suitable for use as a pigment, has been devised by Mr. D. Tyrer, of Stonleigh, West Villas, Stockton-on-Tees.

It is obtained by heating ferrous chloride in a current of air and steam. The ferrous chloride, preferably in granular form obtained by evaporating pickle liquor while stirring, is spread on the floor of a muffle furnace and air moistened by passing through water at 60° C. is heated to 250-300° C. and passed over it. The exit gas is cooled to obtain hydrochloric acid, and the rate at which the current is passed should be such *that the acid condensed contains not more than* 30 grams H.Cl per 100 cc. The gases leaving the condenser are passed to a scrubber fed with water or pickle liquor. Iron compounds decomposable under the conditions of the process, such as hydrated ferric oxide or ferrous carbonate, which may be in the natural condition, may be mixed in finely divided form with the ferrous chloride, and in that case the temperature may be carried higher, for instance to 350° C. There may also be added to the ferrous chloride small quantities of salts having a catalytic effect, namely, salts of copper, magnesium, tin, sodium, and potassium. The addition of a copper salt is stated to improve the red colour of the product.

Messrs. Rayner & Co. will obtain printed copies of the published specifications, and forward on post free for the official price of 1s. each.

THE CHEMICAL NEWS,

VOL. CXXV., No. 3261

THE FARADAY SOCIETY.

ANNUAL GENERAL MEETING, NOVEMBER 20TH, 1922.

The following nominations for Officers and members of Council have been made by the Council:—

President: Sir Robert Robertson, K.B.E., F.R.S.

Vice-Presidents: Professor C. H. Desch, Professor F. G. Donnan, F.R.S., Dr. J. A. Harker, F.R.S., Professor T. M. Lowry, F.R.S., W. Murray Morrison, Professor J. R. Partington, Dr. G. Senter.

Treasurer: Robert L. Mond.

Council: W. R. Bousfield, K.C., F.R.S., Cosmo Johns, Dr. R. Lessing, Professor W. C. McLewis, Professor J. W. McBain, Dr. H. Moore, C. C. Paterson, Dr. N. Pring, Professor A. O. Rankine, Dr. E. K. Rideal.

Secretary and Editor: F. S. Spiers, O.B.E.

"THE GENERATION AND UTILISATION OF COLD."

A general discussion will be held on the above subject by the Faraday Society and the British Cold Storage and Ice Association on Monday, October 16th, 1922, at the Institution of Electrical Engineers, Victoria Embankment, W.C.2.

Programme.

Session I.—2.30-4.15 p.m.

Chairman: Professor Alfred W. Porter, D.Sc., F.R.S., President of the Faraday Society.

(1) *Introductory Remarks*, by the CHAIRMAN.

(2) *Laboratory Methods of Liquefaction and the Measurement of Low Temperatures in Connection Therewith.*

i. Opening address, by PROFESSOR H. KAMERLINGH ONNES.

(In the unavoidable absence of Professor Kamerlingh Onnes, owing to the sudden death of his colleague, Professor J. P. Kuenen, his address will be communicated by Dr. Crommelin.)

ii. *Description of the equipment of the Cryogenic Laboratories at Leyden*, by DR. CROMMELIN.

iii. *Investigations on ethyl and methyl chloride*, PROF. C. F. JENKIN.

iv. *Practical Methods of calibrating Low Temperature Thermometers*, DR. EZER GRIFFITHS.

v. *Practical Methods of Measuring Low Temperatures*, MR. C. R. DARLING.

Interval for Tea.

Demonstrations by Messrs. Liquid Air (Limited).

Session II.—4.45-6.15 p.m.

Chairman: Mr. George Goodsir, President of the British Cold Storage and Ice Association.

(3) *Industrial Methods of Liquefaction and Practical Applications of Low Temperatures.*

i. Opening address, by MR. K. S. MURRAY.

ii. *Applications in Aeronautical work*, DR. EDGAR A. GRIFFITHS.

Discussion.

Interval for Dinner.
(See separate notice.)

Demonstrations by Messrs. Liquid Air (Limited).

Session III.—7.45-10.0 p.m.

Chairman: Mr. James Swinburne, F.R.S., Past President of the Faraday Society.

Consideration of above subject continued.

iii. *The Industrial Manufacture of Hydrogen by the Partial Liquefaction of Water Gas*, MONSIEUR G. CLAUDE.

Discussion.

THE ABSORPTION OF LIGHT BY SULPHUR AT VARIOUS TEMPERATURES.

By MITSUHARU FUKUDA.

It is well known that sulphur changes its colour when heated. This is due to a shift of the absorption band. Generally, the absorption band of a substance moves toward the less refrangible side as its temperature rises. The writer made an experiment to study how the absorption band of sulphur shifts with the variation of the temperature, and the result obtained is given below.

A thin layer of sulphur whose absorption was to be studied was prepared in the following way: a small quantity of the substance was put between two glass plates, and this was slowly heated by a Bunsen-

burner until the hole was uniformly melted.

One junction of a thermo-couple consisting of platinum and tungsten was then inserted into the melted sulphur, and the whole was uniformly heated in an air-bath, the temperature of the other junction being kept constant by means of running water. The above thermo-couple consisted of fine wires of platinum (0.02 mm. dia.) and tungsten (0.035 mm. dia.), they being joined together in a flame of a carbon arc. The couple thus made was previously calibrated up to 300° C. in vacuum oil, the temperature of which being determined by a mercury thermometer.

Next, the absorption spectra of the sulphur at various temperatures were examined with a spectrograph having a replica grating. As the source of light, a carbon arc fed with a salt of calcium was used, and wave lengths of an edge of the absorption bands at various temperatures were determined from the reference lines of calcium. The wave lengths of the edge of the absorption bands determined from these photographic plates did not differ more than 3 $\mu\mu$. The wave lengths of one edge of the absorption band at various temperatures are given in the following table.

Temperature of the Sulphur.	Absorption.
0° C.	From ultra-violet to λ 0.408 μ
20° ,,	,, λ 0.410 ,,
60° ,,	,, λ 0.420 ,,
115° ,,	,, λ 0.430 ,,
120° ,,	, λ 0.435 ,,
160° ,,	,, λ 0.446 ,,
180° ,,	,, λ 0.450 ,
200° ,,	,, λ 0.458 ,,
210° ,,	,, λ 0.460 ,
250° ,,	,, λ 0.473 ,,
300° ,,	From ultra-violet to λ 0.488 μ

(Thickness of sulphur: 0.3 mm.)

Thus, the less refrangible edge of the absorption band of sulphur proceeds toward the red as its temperature was raised, and within the range of the experiment, the rise of the temperature by 10° C. produces a shift of about 2 $\mu\mu$.

According to the investigation of Kellas,[1] the molecular complexity of the liquid sulphur between 115° C. and 160° C. was represented by S_6, while polymerization from S_6 to S_{18} occurs at a temperature of about 160° C., the latter remaining stable up to the temperature of the boiling point of the sulphur. Now, if the molecular complexities S_6 and S_{18} would absorb different parts of the spectrum, the absorption band of the sulphur should change suddenly in the neighbourhood of 160° C., so that an abrupt bending or discontinuity might be expected in the above line. In the experiment described above, many photographs were taken especially in the neighbourhood of this temperature. No trace of any bending or discontinuity was, however, observed, the edge of the absorption band extending gradually toward the red with the rise of temperature.

Now, if the straight line in the above figure is produced toward the negative side of the temperature axis, it will pass the point (λ=0.390 μ, T=-50° C.). Since λ0.397 μ is the violet end of the visible spectrum, the above indicates that the sulphur will transmit all the visible part of the spectrum when cooled down below -50° C. This confirms the observation of the previous investigators.

Next, the absorption of light by sulphur in a plastic state was studied.

Temp. of Sulphur		Edge of Absorption Band		
before cooling.	after cooling.	before cooling.	after cooling.	untreated one corresp. to temps. given in the second column.
300°C.	100°C.	0.488 μ	0.453 μ	0.418 μ
,,	50°C.		0.441 ,,	0.418 ,,
,,	20°C.		0.435 ,,	0.410 ,,
,,	10°C.		—	9.405 ,,
200°C.	100°C.	0.458 ,,	8.440 ,,	0.428 ,,
,,	50°C.		0.434 ,,	0.418 ,,
,,	20°C.		—	0.410 ,,
,,	10°C.		0.430 ,,	0.405 ,,

1 *J. Chem. Soc.* CXIII., pp. 903-922, 1918.

The sulphur was first heated to a high temperature, and this was then suddenly put into water at various temperatures. The plastic sulphur thus prepared was squeezed between a pair of glass plates, and this was examined in the way described above. The result is given in the above table.

From this, we see that the absorption of light by the plastic sulphur is not simply determined by its present temperature, but it also depends upon the initial temperature to which the sulphur was previously heated. The higher the initial temperature, the longer is the wave length of the edge of the absorption band.

Now, sulphur has two modifications S_6 and S_{18}, and if the sulhur at 300° C. was gradually cooled down to 100° C. for example, S_{18} would completely transform into S_6, but if it was rapidly cooled, this is not the case, because its absorption spectrum corresponds to that of a higher temperature of about 180° C. Thus, the plastic sulphur will consist of S_6 and S_{18} mixed in a complex way.

In conclusion, the writer wishes to express his thanks to Prof. M. Kimura for his kind guidance.

(From "Memoirs of the College of Science," Kyoto Imperial University.)

[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF THE UNIVERSITY OF ILLINOIS.]

OBSERVATIONS ON THE RARE EARTHS. XII. THE ATOMIC WEIGHT OF LANTHANUM.

BY B. S. HOPKINS AND F. H. DRIGGS.

During the progress of the work upon the rare-earth group, there was received at this laboratory a shipment of 182 kg. of sodium rare earth sulphates, which was generously supplied by the Welsbach Company, of Gloucester, New Jersey, and its chief chemist, Dr. H. S. Miner. The early treatment of this material[1] consisted in the removal of cerium by the method proposed by James and Pratt, and fractional crystallisation as the double magneisum nitrate. This work was done by Dr. Edward Wichers. Later the fractions from the insoluble end of the series which contained lanthanum and praseodymium were subjected to a long series of fractional crystallisations as the ammonium-rare earth nitrates the care of Dr. E. W. Engle. The fractionation was continued until the first 20 fractions failed to show the slightest trace of praseodymium in their absorption spectra, when viewed through a 10 cm. layer of concentrated solution.

PURIFICATION OF MATERIAL.

Portions of Fractions 7 and 8 of the double ammonium nitrate series were diluted and treated with a hot dil. solution of oxalic acid. The precipitate was washed, dried and ignited to the oxide in an electric muffle. The oxide was redissolved in nitric acid, diluted to 2,000 cc. and lanthanum hydroxide precipitated by distilling ammonia vapours into the solution. This precipitate was washed thrice by decantation and redissolved in nitric acid. The alternate precipitation of hydroxide and oxalate was repeated four times, the last two precipitations being carried out in conductivity water. The ignited oxide was then suspended in conductivity water and dissolved by passing over it the vapour obtained by distillation of c. P. hydrochloric acid from a quartz flask.

A portion of Fraction 8 of this series was sent to the Bureau of Standards, where it was examined spectroscopically by the use of 4 gratings, 1 of 7,500 lines per inch for the infra-red region, 1 of 10,000 lines per inch and 2 of 20,000 lines per inch for other portions of the spectrum. Photographs were made in the region between 5500 A. and 9000 A., and these "have been compared with similar results derived by Eder from Auer von Welsbach's preparation." The material was found to be "of a high degree of purity, no lines being found thus far which can be attributed to any of the related elements."[3]

All the reagents used in this investigation were carefully purified by the identical methods that have been used and described in earlier publications from this laboratory.[4]

PREPARATION OF ANHYDROUS LANTHANUM CHLORIDE.

Two methods were used in the preparation of the anhydrous chloride. The first consisted in placing a portion of the chlor-

1 See Hopkins and Kremers, *Bur. Standards Sci. Papers*, 421, *Part II*. (1921).

2 James and Pratt, *Jour. Amer. Chem. Soc.*, 33, 1326 (1911).

3. "*Report on Progress of the Study of the Spectra of the Rare Earth Elements*," *Bureau of Standards, Sept.*, 1920.

4 Kremers, Hopkins, and Engle, *Jour. Amer. Chem. Soc.*, 40, 601 (1918).

ide solution in a quartz reaction flask and drying in a current of air and hydrogen chloride until the salt began to crystallise. The air was then stopped and only hydrogen chloride was passed through. The temperature was maintained below 85° by means of an electric oven until the first 5 molecules of water had been driven off. The temperature was then gradually raised to 125° when the last molecule began to come off. As soon as this evolution was complete the temperature was raised to 325° and kept at this point for 1 hour, after which the salt was rapidly fused in the Bunsen flame.

Due to the slow removal of water from the chloride solution by this method, the last 5 determinations were made by first evaporating the lanthanum chloride solution to a small volume and separating the salt by saturating the solution with hydrogen chloride. The hydrated salt was filtered, dried and crushed in an agate mortar and kept in a desiccator over fused potassium hydroxide. A portion of this was introduced into the reaction flask for each determination and the dehydration carried out as described in the preceding paragraph. This method enabled us to prepare the anhydrous chloride much more quickly and satisfactorily than when the chloride solution was introduced into the reaction flask.

Determination of Atomic Weight.

After fusion of the anhydrous salt in the reaction flask the hydrogen chloride was displaced by passing air through the apparatus until the escaping air gave no test for chloride when bubbled through a silver nitrate solution. The caps on the outlet and inlet tubes were then adjusted, and the flask was hung in the balance case for several hours and weighed.

The fused lanthanum chloride was then dissolved in conductivity water, transferred to an Erlenmeyer flask and diluted to about 1,000 cc. Silver was etched and weighed to within 1 mg. of the calculated amount, dissolved in redistilled nitric acid and diluted to about the same volume. The silver solution was then added to the chloride solution with constant shaking and placed in a shaking machine overnight. The clear solution was tested in a nephelometer for excess of silver or chloride, and the calculated deficiency was added from a standard solution of silver nitrate or sodium chloride until the nephelometer indicated equivalence.

The weighings were made by the method of substitution, the tare flask used being of quartz and differing in weight from the reaction flask by only a few milligrams. The weights were standardised to 0.01 mg., and weighings were corrected to the vacuum standard.

The following densities were used: lanthanum trichloride, 3.947;[5] silver, 10.5; weights, 8.4. The atomic weight of silver was taken as 107.88, and that of chlorine as 35.457.

Table I.

No.	Wt. of $LaCl_3$ Gram.	Wt. of Ag. Gram.	Ratio	At. Wt. of La.
1	0.60680	0.80078	0.75776	138.87
2	0.73504	0.96987	0.75787	138.91
3	1.02450	1.35189	0.75783	138.89
4	0.92965	1.22654	0.75794	138.93
5	1.84436	2.43317	0.75807	138.97
6	0.72863	0.96164	0.75769	138.85
7	0.52934	0.78180	0.75766	138.84
8	0.98017	1.29330	0.75788	138.91
9	1.02852	1.35729	0.75778	138.88
10	0.85193	1.12428	0.75775	138.87
			Av. At. Wt.	138.89

Summary.

On the basis of 10 determinations of the atomic weight of lanthanum by the precipitations of the chloride, the average value of 138.89 was obtained, in excellent agreement with the value 138.91 found by Baxter, Tani and Chapin.[6] The close agreement of these two results indicates that the value selected by the International Committee, 139.0, is slightly too high.

Urbana, Illinois.

(From "Memoirs of the College of Science," Kyoto Imperial University.)

6 *Baxter, Tani and Chapin, Jour. Am. Chem. Soc.* 43, 1080 (1921).

5 *Compt. rend.*, 140, 1339 (1905).

ON THE COLOUR OF COLOURED FLUORITES.

By Tokutaro Sakao and Mitsuie Hirose.

The cause of the colours of Blue John and other varieties of fluorite has long been a matter of doubt and controversy. Messrs. Blount and Sequeira carried out an interesting investigation on the problem, and the result was briefly described in the Transactions of the Chemical Society.[1]

According to their conclusion there is no substantial difference between a white fluorite and blue, green and amethystine varieties, except the presence of a small amonnt of organic matter, and the colours are ascribed to this organic matter. But the state of dispersion of the latter is not discussed.

Now it is already ascertained that the blue colour of certain varieties of rock salt is due to a colloidal dispersion of sodium in sodium chloride, and that the blue colours of sodalite and ultramarine are almost certainly due to a similar cause. As was suggested in *Nature*,[2] though the colour of the fluorites is ascribed to the presence of some organic matter, yet the problem is not completely solved. The present writers, under the suggestion of Prof. M. Kimura, attempted an experiment to examine by means of an ultra-microscope the state of the suspected organic matter in the crystal, and a short account of the result obtained will be given below.

In the present experiment the following specimens were selected and examined.

(1) A piece of a transparent crystal, one half of which was coloured amethystine, while the remaining part exhibits a green colour.

(2) A piece of a green fluorite having a transparent stria.

(3) A piece of perfectly transparent fluorite.

(4) two pieces of green fluorite, one of which is more deeply coloured than the other.

(5) A colourless crystal obtained by baking a piece of a green variety.

Small pieces of the crystal mentioned above were selected from several pieces of the crystal; and they were cut into parallel plates having a thickness about 1 mm., and then the surfaces were polished with emery and then rouge, to secure an optical surface. The plates prepared were examined with an ultra-microscope having a cardioid condenser, illuminated by the light from a 20-ampere carbon arc.

In all the coloured specimens mentioned above a uniform distribution of an immense number of particles as is usually seen in the case of coloured glasses and of colloidal solutions could not be detected at all, the only thing observed being a very few bright particles. These particles were distributed very irregularly and their number varied from plane to plane within the crystal, the total number seen in a field of view being not greater than about ten.

In a transparent portion of the crystal such particles were also observed, and their number and mode of distribution did not present a sensible difference even in crossing at the boundaries of a transparent stria in the green fluorite. Moreover, in certain specimens it was ascertained that a weakly coloured crystal contains a larger number of the bright particles than a highly coloured one.

These facts seem to indicate that the particles under consideration have no relation with the cause of the colour of the fluorite. As to the nature of these particles no definite conclusion can be drawn from the present experiment, but we may consider that the particles might be minute holes or some impurities contained within the crystal.

If the particles were totally taken out of consideration the coloured fluorite is optically clear. This means that if the organic matter found by Blount and Sequeira be in a state of colloidal suspension, it should have the same index of refraction as that of the fluorite, or that the colloidal particles should be too fine to be detected in the present experiment. Otherwise, the organic matter would be scattered into the molecular state in the crystal.

1. Vol. 115, 705 (1919).
2. *Nature*, Sept. 13, 1919.

BRITISH ASSOCIATION.

Fuel Economy.

V. Domestic Heating and Cooking Appliances.

(*Continued from Page* 197.)

A good deal of valuable investigation work has recently been done by persons not actually engaged in the industries concerned in the direction of testing the efficiencies of domestic heating and cooking appliances, with results of considerable interest in connection with the importan

question of fuel economy in our homes, where are burnt not only some 40 million tons of coal per annum, but also the bulk of the gas and some of the coke sent out from the country's gasworks.

In the first place, physiological research has emphasised the intimate connection, from the point of view of health and comfort, between the cognate problems of heating and ventilation in regard to domestic apartments. Moreover, the introduction of the Kata-thermometer has placed at our disposal a new method for estimating the "cooling power" of the air, which has been shown to be a governing factor in regard to what may be termed "comfort conditions" in living rooms. Also, the physiological value of radiation from a red-hot incandescent surface, as distinct from convected heat, has become to be more clearly recognised than ever before. Indeed it may be said that the more nearly the conditions under which our living rooms are warmed and ventilated approach those of a warm summer's day—a cooling breeze blowing round the head, the varying sunshine warming one side of the body, and the warm ground for the feet—the more comfortable and healthful will they be. The desirability of such conditions, which may be contrasted with the warm air of rooms heated by convection from steam coils, probably explains the Englishman's decided preference for the the radiation from an open fireplace duriug our dreary British winters over the various forms of central heating which are favoured in America and other countries where the winters are colder but brighter. Therefore, having regard to the character of British winters, the estimation of the " radiant efficiencies " of domestic fires is of predominant importance.

The " radiant efficiency " of a modern gas fire may he said to be ahout 50 per cent. on the *net* calorific value of the gas burnt therein; moreover, experiments made under Professor W. A. Bone's direction at South Kensington have proved that, within wide limits, such radiant efficiency is independent of the chemical composition and calorific value of the gas burnt, provided that the number of calories by combustion developed per hour is kept suitably constant for the particular size of fire. Gas fires are now available which are capable of ventilating rooms quite as well as an open coal fire; and it may be taken for granted that both these appliances are capable of providing a healthful source of radiation for the warming of living rooms without unduly heating the atmosphere thereof. With regard to electric radiators, whose radiant efficiency may be as high as 75 per cent., while these are very portable and therefore convenient for placing where the heat is required, they do not directly ventilate an apartment.

The recent determination by Dr. Margaret Fishenden, for the Manchester Corporation Air Pollution Advisory Board, of the radiant efficiencies of coal, coke, and semi-coke when burnt in open fire-places (Fuel Research Board Special Report, No. 3) are of considerable interest. Her experiments have shown, not only that such efficiency is much greater than has generally been supposed, but also that there is not so much difference as might be thought between the efficiencies of different grates.

Working with a number of coal-fired open grates, including what were supposed to be the best and the worst types, the radiant efficiency in all cases was found to lie between 20 and 24 per cent. of the heat of combustion of the coal actually burnt during each test. When *dried* coke was used as fuel, radiant efficiencies up to 25 and even 28 per cent. were obtained: the values were, however, materially diminished when wet coke was used. Tests made with the low-temperature carhonisation "semi-coke" gave radiant efficiencies of up to 33 per cent. in a grate which with ordinary coal gave 25 per cent. It is also to he noted that the tests showed that, within the limits likely to be encountered in practice, with domestic fire-grates the radiant efficiency was found to be independent of the draught intensity, and also confirmed previous experience that treatment of the fuel with preparations (consisting mostly of common salt), which are sometimes advertised as doubling the value of a ton of coal, had no appreciable effect npon its radiant efficiency. Altogether, then, Dr. Fishenden's investigations may be said to have gone far to remove from the open fire-place tthe stigma of gross inefficiency.

The Fuel Research Board have also published some work by Dr. Fishenden which deals with the efficiency of kitchen appliances (Fuel Research Board Technical Paper No. 3: " The Efficiency of Low-temperature Coke in Domestic Appliances "), and, in addition, one of the members of our Committee (Mr. A. H. Barker) has also devoted considerable time to the difficult question of the determination of the efficiency of domestic cooking appliances. A memorandum by him on

the subject is appended to this Report, the results of his experiments having been published in detail by the Fuel Research Board (Special Report No. 4).

Dr. Fishenden has concerned herself with the determination of the radiant efficiencies of the ranges examined, as well as their efficiency in the production of hot water, whereas Mr. Barker has concerned himself generally with the question of the efficiency of ranges when functioning for the production of hot water or for cooking. The latter Report also touches upon the question of gas and electric cookers, but the Committee does not propose to comment upon this aspect of the case, as it would appear to require further investigation.

Whilst perhaps it would be premature to express any final opinion as to the precise significance of the results obtained, in view of the fact that the work is from the experimental point of view in its infancy, and that rather marked differences in efficiencies are cited in the two Reports, due probably to differences in the type of range tested, the Committee desires to call attention to the very great interest of the work at the present juncture, and to the desirability of the inquiry being continued.

The combination of several different functions, namely, of a fire-heated oven, a fire-heated hotplate, a fire-heated boiler, and also a fire to warm the kitchen, would appear to involve heavy fuel consumption, as compared with the fuel required for appliances designed to perform these functions separately. Thus, for example, Dr. Fishenden obtained a water-heating efficiency of 17 per cent. from an old-fashioned open kitchen range, whilst a later type of independent boiler—which also functioned as an open fire—gave an efficiency of 35 per cent. for water heating, and, in addition, an open fire radiation of 7 or 8 per cent. Moreover, Mr. Barker's tests yielded hot-water efficiencies varying from 7 to 17 per cent. in kitchen ranges, as against efficiencies of 40 to 50 per cent. obtainable with separate hot-water supply apparatus.

Mr. Barker's work indicates also that the existing designs sacrifice fuel economy to convenience in providing an exposed hotplate adjacent to the oven, and that the fuel consumption for oven cooking may be reduced by lagging the hotplate. It is difficult to assess the value of the house heating done by the present-day kitchen range, but any detailed review of the subject should make some endeavour to assess its value.

In the Committee's Report in 1916 it was stated that "the whole question of the domestic use of fuel bristles with difficulties and complications . . . the solution or recommendation of particular means or apparatus for domestic heating cannot always be based simply upon the question of thermal efficiency, because it also involves considerations of a physiological and even of a psychological character. In the vast majority of houses inhabited by the artisan population, the kitchen fire or stove is the only place in the house where fuel is burned." In addition, it might be added that in the latter type of house prime cost often becomes the determining factor, and sacrifices of efficiency have to be made to ensure a small capital outlay.

The Reports under review appear to the Committee to justify a reconsideration of the factors underlying the design of solid fuel types of domestic appliances with a view to determining whether improvement in fuel economy can be obtained without either an unreasonable sacrifice of convenience or an excessive addition to the cost of production. In very many cases the actual dweller has had no say in the selection of the kitchen range, nor has he the means or the facilities for replacing such as may have been provided for him.

With regard to the existing types of combined range, it is felt that attention should be called to one point in Mr. Barker's Report, namely, that the CO_2 content of the flue gases did not exceed 5.5 per cent. in the best ranges tested, and that in several cases it was much below this, suggesting that in some cases sufficient attention has not been paid to the regulation of the air supply.

The Committee would suggest the following three points for more general consideration: (1) The general adoption of means to reduce the excess of air drawn through the system by so enclosing the fire that air does not get to the combustion chamber otherwise than through the fire grate, although retaining a feature which characterises existing appliances in providing means to enable an open fire to be obtained for kitchen heating when the other functions of the range are not required; (2) the use of effective lagging of oven doors which is not generally adopted at present; (3) the desirability of removing the ordinary hot-water boiler from the range and the sub-

stitution therefor of an independent boiler, separately fired; at present it would appear that such combinations are only provided in a limited number of middle-class houses, or in the case of very large ranges.

VI.—Steam Raising and Power Production.

The Committee desires to call attention to the great need there is for some more systematic effort on the part of steam users to improve the present admittedly unsatisfactory state of boiler practice throughout tthe country, especially in the direction of educational provision for the better training of stokers and power-station superintendents. Notwithstanding the greater attention which is nowadays paid to the subject of "efficiency" in some of the larger steam-raising installations and power-stations, there still exists in far too many cases a lamentable disregard for the elementary principles of good boiler management. Indeed, it may be doubted whether, taking the country as a whole, the average efficiency of steam-raising exceeds 60 per cent. on the calorific value of the coal burnt, whereas if scientific operations replaced rule-of-thumb working it might be raised to 75 per cent., with consequent great saving in fuel.

The most frequent and serious cause of avoidable heat-wastage in current boiler practice arises from the fact that unnecessarily large excesses of air are usually drawn through the system owing to sheer neglect of some of the most obvious precautions. With good management it should be possible, by careful damper regulation and maintaining a correct depth of fire, to burn completely an average quality of steam coal with no greater excess of air than would give about 12 per cent. of CO_2 (without appreciable quantities of CO) in the chimney gases; but far too frequently as much as twice such minimum excess of air is drawn through the system. It is not sufficiently realised how highly important to fuel economy are the proper regulation of the draught by dampers, the correct proportioning of grate area to the quantity and size of the coal burnt, and the avoidance of inleakage of cool air into the boiler setting by keeping the brickwork in good repair and well pointed, and efficiently caulking the joint between the brickwork and boiler shell. Proper atttention to such elementary points would reduce the "sensible heat" lost in the chimney gases to 18 per cent. of the total calorific power of the coal burnt, whereas neglect of them often means twice such loss.

Whilst the more general use of indicating and recording apparatus may be recommended as the best automatic aids to good management, yet unless these are supplemented by intelligence and watchfulness on the part of both stokers and boiler-house superintendents, they will not avail much or may be actually misleading. The Committee, therefore, desires to impress upon both manufacturers and the public education authorities the need there is not only of better boiler-house supervision, but also of the better instruction and training of the boiler-house personnel. It cannot be urged too often upon steam users that considerable economies can be effected with existing plant and appliances, provided that they are run under the skilled supervision of properly trained men. In the case of large boiler installations it will usually pay to put them under the control of a well-trained fuel technologist, and there are several institutions in the country where such men are being scientifically as well as practically trained. Local education authorities could effectively help fuel economy by instituting in the various technical schools throughout the country properly organised classes for the instruction of stokers and the lower grades of boiler-house attendants. In addition to such classes, the institution in some of the larger centres of more advanced and specialised lectures, with opportunities for discussion, upon combustion, heat transmission, and boiler management generally for boiler superintendents and engineers, would undoubtedly be of great advantage.

In connection with the production of electric power by Public Utility Undertakings, the Committee would point out that the Electricity Commissioners could render a great national service if, in their annual returns, they would publish such financial and detailed technical data as are necessary to show the actual fuel consumptions and total cost of production per unit of output in the various individual power stations throughout the country. The present annual returns are not sufficiently detailed for this purpose, and in particular do not show the circumstances (such as load factor) under which the current is produced. It would undoubtedly stimulate healthy competition, promote fuel economy, and reduce costs, if the individual power stations were required to furnish for publication all the necessary technical data to enable fair comparisons to be made.

VII. Smoke Abatement.

During the past year the Departmental Committee appointed by the Ministry of Health "*to consider the present state of* the law with regard to the pollution of the aid by smoke and other noxious vapours, and its administration, and to advise what steps are necessary and practicable with a view to diminishing the evils still arising from such pollution," has issued its final Report. After full consideration of the matter, it was not thought practicable at present to propose legislation dealing with smoke from private dwelling houses, although it was estimated that as much as 2½ million tons of potential fuel in the form of soot escape annually into the atmosphere from domestic fire-places, as against only 500,000 tons from factory chimneys, which latter seems a very low figure. It was, however, recommended that the Central Housing Authority should have certain supervisory powers in regard to heating methods over housing schemes submitted by local authorities, and that the latter be empowered to make by-laws requiring the provision of smokeless heating arrangements in new buildings other than private dwelling houses. This is probably as far as it is practicable to go in the present state of public opinion; for it seems wiser to rely upon its further education and enlightenment rather than upon vexatious legislative prohibition for the abatement of domestic smoke.

With regard to the question of industrial smoke, it was recommended by the Departmental Committee: (1) that the Ministry of Health should be given clearly defined power to compel or act in place of any defaulting authority which refuses to perform its duties in administering the law with regard to smoke; (2) that, instead of the present absolute prohibition, which it is impossible to observe, there should be imposed upon all manufacturers, users and occupiers of any business premises or processes, engines or plant of any description whatever, a general legal obligation to use the best practicable means, having regard to all the circumstances of the case, including the question of cost, for avoiding pollution of the air by smoke, grit, or any other noxious emissions; (3) that the same law should also apply to all Government establishments, and all rail and road locomotives and motor cars of whatever weight and type, and to steamers on rivers, estuaries, and lakes; (4) that the Ministry of Health should be empowered to fix smoke standards from time to time; (5) that the duty of enforcing the law with regard to the pollution of the air by smoke should be transferred from the local sanitary authorities, in whose jurisdiction it now rests, to the county authorities—*i.e.*, the Councils of Counties and County Boroughs, albeit that minor authorities should still have the power to take proceedings, if they so desire; (6) that for proved breaches of the law much larger fines should be imposed than at present; and (7) that the Minister of Health should assign to one or more competent officers the duty of advising and assisting local authorities and manufacturers with regard to difficult smoke problems, and that such officers should report annually in the steps which are being taken, and the progress which has been made, in the suppression of avoidable smoke.

Since its inception in 1915, this Committee of the Association has carefully considered data and proposals relating to the causes and prevention of industrial smoke, and has been pleased to note progressive improvement, due largely to the increasing study of fuel economy in its various branches in regard to smoke abatement throughout the country, and that the Ministry of Health has taken evidence with a view to passing further legislation on more rational lines than that at present existing, which has become very much of a dead letter by reason of the extreme remedies it proposes.

It must be remembered that, even with the best appliances used with the greatest care, it is practically impossible altogether to prevent black smoke being produced for some small portion of the time when raw bituminous coal is burnt, and that in some industrial operations more smoke is apt to be produced than in others. It is evident, therefore, that no legislation should penalise the emission of what may be reasonably considered to be the *minimum* amount of smoke by competent judges who are familiar with the nature and the requirements of the particular industrial operation concerned. Indeed, it may be predicted that any attempt to do so would probably be as ineffective as the present enactments, and would thereby merely defeat its own purpose.

This Committee, having carefully considered the matter in its various aspects, has come to the conclusion that the best

way of further abating the pollution of the atmosphere by smoke would be the institution by the Ministry of Health of a national Smoke Inspectorate on similar lines to the already existing Alkali Inspectorate, which has admittedly worked well and with beneficial results to the industry concerned.

Changes in Membership.—Since its last reappointment the following changes have taken place in the membership of the Committee. Mr. E. Bury retired on account of frequent absence abroad; Sir Joseph Walton, M.P., retired on account of ill-health, and Mr. Robert Armitage, M.P., was co-opted in his place. Mr. Wallace Thorneycroft has been co-opted in the place of the late Mr. G. Blake-Walker, and Mr. E. Myers in the place of Mr. D. V. Hollingworth. Also the following new members have been co-opted during the year: Messrs. J. E. Hackford, H. Stafford Rayner, L. L. Robinson, and W. C. P. Tapper.

The Committee recommends that it be reappointed to continue its investigations, with a grant of £5.

APPENDIX.

Memorandum on Determining the Efficiency of Cooking Appliances.

The efficiency of appliances for the utilisation or transformation of heat energy cannot be regarded so definite a function as in the case of mechanical or electrical ones. Since no non-conductor of heat is known, the actual thermal efficiency, however determined, must be variable according to the conditions.

In the case of cooking ranges and appliances, the conditions are so variable and complicated that it is difficult to devise test methods which shall invariably produce approximately the same numerical result from the same appliance on two or more separate occasions. Unless this is done, any figures must necessarily be uncertain, and no reliable comparison can be made between two different appliances in respect of efficiency.

In order that such figures should bear close relation to the efficiency of the appliance as used in practice, it is desirable that the experiments should be made under conditions similar to those in which the appliance is actually used, but unfortunately this is, in the nature of things, impossible. No reliable figures could be obtained while the apparatus was in use in cooking an actual article of food, because the amount of heat transmitted to such material cannot be measured, and also because of the extreme variations which arise in all the observable physical magnitudes during such an operation. Thus it is impossible to say when two similar joints are cooked to the same degree. It is, therefore, essential that the object heated for test purposes should be very different from an article of food, and such that the heat communicated to it should be capable of exact measurement.

(To be Continued.)

BRITISH ASSOCIATION.

SECTION K—BOTANY.

TRANSPORT OF ORGANIC SUBSTANCES IN PLANTS.

ADDRESS BY PROFESSOR H. H. DIXON, SC.D., F.R.S., PRESIDENT OF THE SECTION.

(Continued from Page 205.)

As the stimulus travels both in a basipetal and acropetal direction, we may assume that movement of the transpiration-stream in a downward direction is of normal occurrence in plants.

Contemporaneously with, and subsequently to, Ricca's important work on Mimosa, experimental evidence has been accumulating to indicate that the transmission of other stimuli—viz., phototropic, traumatotropic, thigmotropic, and geotropic—is effected by means of the passage of a dissolved substance. Boysen-Jensen appears to have been the first to announce that phototropic and geotropic stimuli may be transmitted across protoplasmic discontinuities. Paál emphasised this by showing that these stimuli are able to pass a disc of the tissue of *Arundo donax* impregnated

with gelatine, which is interposed between the receptive and responding regions. These observations rendered the view that the stimulus is transmitted in the form of a hormone extremely probable; and later Stark showed that this hormone is thermostable, just as Ricca had done in the case of the hormone of Mimosa. Another very interesting point discovered by Stark—working with traumatic stimuli—is that the hormones are to a certain extent specific. Thus if the perceptive tip of a seedling is removed from one plant and affixed in position on another, the certainty of the response depends on the genetic affinity of the two plants.

In all these cases it seems certain that the perceptive tissues are the point of origin, when stimulated, of a dissolved substance, the hormone, which makes its way to the motile tissues and releases the response.

In the case of Mimosa just alluded to, and of the labellum of Masdevallia examined by Oliver, there is direct evidence that the transmission of the hormone is effected by the vascular bundles. In Mimosa the channels are more precisely localised as being the tracheæ of the wood. Furthermore, the rapidity of transmission renders it certain that simple diffusion through the tissues of the plant will not account for the process. Some recorded velocities of transmission are here enumerated for the sake of comparison:—

Plant.	Nature of Stimulus.	Transmission Time in secs. per mm.
Mimosa	Heat	0.07
Drosera	*Chemical*	6.00
Seedling	Light	180--300
,,	Gravity	300
Tendril	Contact	17
Diffusion in tissue	. . . .	2250--3600

There is thus every reason to believe that the transmission of stimuli generally through the tissues of the higher plants is effected by the conveyance of a hormone in the wood of the vascular bundles from the receptive to the motile regions, and whenever this transmission is in a downward direction evidence is afforded of the downward movement of water in the tracheæ. It is reasonable to suppose that this downward current is able to carry organic foodstuffs as well as hormones.

Thus the evidence for the existence of a backward flow of water in the tracheæ of wood, in addition to the more obvious upward stream, is convincing. With regard, however, to the mechanism by which the backward stream is supplied we have but scant information.

The volume-changes of leaves which Thoday has recorded are suggestive in this connection. These changes he found of various magnitudes, occurring simultaneously in different or in the same leaves. They may cause a linear contraction amounting to 2.5 per cent. in ten minutes, and may produce a volume contraction of 7 per cent. in the same time. The water corresponding to this volume-change in the cells of the leaf if transmitted into the tracheæ would produce a considerable downward displacement, as may be seen from the following figures:—

Name of Plant.	Volume of 1 per cent. contraction in mm.	Cross-section of tracheæ in petiole in mm.	Downward movement in cm.
Aucuba japonica	22.8	0.05	45.6
Solanum tuberosum	28.0	0.07	40.0
Syringa vulgaris	42.15	0.013	16.5
Acer macrophyllum	42.2	0.22	19.2

If these changes in volume are caused by, or accompanied with, a development of permeability of the contracting cells, evidently a backward movement of organic substance having a velocity of about 120cm. and more per hour would be produced.

It is possible that the tension which causes these contractions of the leaf-cells at the same time acts as a stimulus to in-

crease the permeability of the plasmatic membranes of the cells; and so one might imagine that the development of a certain tension would automatically release organic substances from the cells and draw them through the tracheæ downwards. Direct experiment on this point presents difficulties, but it may be worth recording that when the internal osmotic pressure of the leaf-cells was overbalanced by an external gas-pressure, the water pressed from the cells and forced out of the tracheæ of the supporting stem was found to be practically pure, and if it contained carbohydrates they were in such small quantities that no reduction could be detected with Benedict's solution either before or after inversion. This experiment was repeated several times with branches of *Sambucus nigra* and *Tilia americana*. The cut branch, well supplied with water, was first exposed for several hours to conditions favourable to photosynthesis, and then either immediately or after a sojourn in darkness subjected to the gas-pressure. A pressure of thirteen atmospheres was found sufficient to drive water back from the leaves out of the stem.

Of course the conditions of this experiment are not those obtaining in the normal plant, where during transpiration the volume of a leaf, or part of a leaf, changes. In the transpiring plant we can also imagine the accumulation of a substance or an ion which would give rise to an alteration of the permeability of the plasmatic membranes of the leaves.

When, in order to imitate these conditions, the cells of the leaves in the foregoing experiment are rendered permeable by the introduction of a little toluene into the pressure-chamber, the application of a smaller pressure is sufficient to press the cell-contents into the water-channels and liquid emerges from the base of the stem which readily reduces Benedict's solution.

In the same way, if a pinna of *Sambucus nigra* is surrounded with toluene vapour, transpiration from the adjacent pinnæ draws back the cell-contents of the toluened pinna, and afterwards their track in the wood of the vascular bundles of the rachis may be traced by the browning of this tissue.

Another possibility presented itself—viz., that the direction of the current might act as a stimulus regulating the permeability of the cells in contact with the tracheæ. To test this, short lengths of stem set in their normal position were supplied, first through their lower and afterwards through their upper end, with distilled water. In neither case could carbohydrates be detected in the issuing stream.

The foregoing short consideration of some recent physiological work leads us, then, to the following conclusions:—

The transport of the organic substances needed in the distal growing regions is effected through the tracheæ of the wood. The substances travel dissolved in the water filling these channels, which is moved by transpiration, expansion of the growing cells, or root pressure.

Physical considerations forbid us admitting that sufficiently rapid transport can be afforded by the bast either for the observed upward or downward distribution of organic substance.

The existence of downward as well as upward movement of water in the tracheæ of the wood may be demonstrated by suitable experimental means, and may be inferred by the transport of hormones in the wood.

The occurrence of local contractions in leaves suggests that local increases of permeability supply dissolved organic substances to the distal ends of certain of the filaments of tracheæ. The tension developed by the transpiration of other regions draws these along downward as well as upward channels in the wood.

In thus ruling out the participation of the bast in the longitudinal transport of organic substances in plants one naturally is forced to speculate on its probable function. Its distribution and conformation are such that, while it possesses a very small cross-section, it appears with the other living elements of the vascular bundles, medullary rays, wood-parenchyma, &c., to present a maximum surface to the tracheæ.

This large surface may find explanation in the necessity of interchange between the living cells and dead conduits. The colloidal contents of the former render this process slow, hence the uecessity for the large surface of interchange to enable sufficient quantities of organic substances to be abstracted from and introduced into the tracheæ to meet the needs of the plant.

Before concluding, I would like to add that the experimental work carried out on this matter would have been quite impossible for me were it not for the assistance and ingenuity of Mr. N. G. Ball. He also has contributed materially by his criticisms and suggestions.

[End.]

[CONTRIBUTION FROM THE JOHN HARRISON LABORATORY OF CHEMISTRY, UNIVERSITY OF PENNSYLVANIA.]

THE SODIUM TUNGSTATES. I.

BY EDGAR F. SMITH.

Wolcott Gibbs [1] wrote:

"The alkaline tungstates are numerous and unusually complex. Salts of essentially different formulas approach so closely in percentage composition, that the differences lie very near the unavoidable errors of analysis. . . . The analyses are hardly sufficiently close to decide the question upon purely analytical grounds." [2]

This comment was evoked on considering more particularly the various sodium tungstates; for, he added:

"As the general result of my own study of the salts themselves and of the work of Scheibler, Marignac, Lotz, Forcher, Laurent, Lefort, and others . . . I have arrived at a new classification and arrangement: the normal and metatungstic series." [3]

Gibbs repeatedly obtained a sodium salt, the analysis of which agreed very closely with the formula, $9Na_2O.22WO_3.51H_2O$, and thought it might be the representative of a new class or series. A glance at Dammer's Handbuch, picking out the recorded sodium salts, discloses at least eight ratios between basic oxide (Na_2O) and acid oxide (WO_3); and, of the $5Na_2O.12WO_3.28H_2O$ salt, containing sometimes less than 28 H_2O, depending upon the manner of its crystallisation, he said its constitution, it was believed by some, was best expressed by the formula $3Na_2O.7WO_3.16H_2O$.

In the Gibbs arrangement there are only three outstanding members claiming consideration: (*a*) normal sodium tungstate; (*b*) sodium paratungstate; and (*c*) sodium metatungstate. To these, through the studies of Gibbs, there should be added $4Na_2O.10WO_3.23H_2O$ and probably $9Na_2O.22WO_3.51H_2O$.

In commencing the present study, the writer desired to prepare a series of derivatives of "complex inorganic acids," starting with *ammonium paratungstate* but, annoyed by its sparing solubility, he turned to its sodium analog, made by the method of Scheibler.[4]

Dammer [5] states that this salt—$5Na_2O.12WO_3.28H_2O$—is produced by adding carbon dioxide to the aqueous solution of the normal salt ($Na_2WO_4.2H_2O$), whereas Forcher[6] got $4Na_2O.10WO_3.23H_2O$, by this procedure.[7] Small, brilliant crystals separated and when they no longer increased appreciably in quantity, were filtered out and washed repeatedly with ice-cold water, until the wash-water did not effervesce on the addition of hydrochloric acid. They were recrystallised.

Forcher was, probably, the first person to observe this salt, to which he ascribed the formula, $2Na_2O.5WO_3.12H_2O$. Marignac obtained it, but was ignorant of the fact that Forcher had prepared and analysed it. Marignac gave it the formula, $2Na_2O.5WO_3.11H_2O$. The literature contains very little relating to the salt.[8]

As the writer, at the beginning, had in mind using various sodium tungstates, namely, those in which the ratio of basic oxide and acid oxide varied, in the preparation of "complexes," this ratio, $4Na_2O.10WO_3.23H_2O$, arrested his attention, and caused him to devote more time to its preparation and to the study of its behaviour, as well as to the properties of allied derivatives. Therefore, the following observations on the salt, $4Na_2O.10WO_3.23H_2O$, are offered, which for convenience, may be designated the 4 : 10-salt.

HISTORICAL.

Despite the possibility of repetition, a brief historic sketch is submitted. Vincenz Forcher, [6] experimenting with the normal salt ($Na_2O.WO_3.2H_2O$) followed a hint pre-

1 *Wolcott Gibbs, Am. Chem. J.*, 1, 218 (1879).

2 *See also Dammer, "Handbuch der anorganischen Chemie,"* 3, *p.* 639; *and Abegg, "Handwörterbuch der anorganischen Chemie,"* 4, *p.* 791.

3 *Gibbs, Am. Chem. J.*, 1, 2 (1879).

4 *Scheibler, J. prakt. Chem.*, 83, 278 (1861).

5 *Dammer, Ref.* 2, *p.* 664.

6 *Forcher, J. prakt. Chem.*, 86, 240 (1862).

7 *See also Lefort, Ann. chim. phys.*, [5] 9, 97 (1876).

8 *Z. anorg. Chem.*, 96, 139 (1916).

viously given by Riche,[9] namely, passed carbon dioxide through an aqueous solution of the normal salt for several days, and obtained the 4 : 10-salt. He busied himself no further with it. Other chemists had it in hand but disregarded it, thinking no doubt that it was an accidental product. But Gibbs[10] gave it study, analysed it not only repeatedly, but also made the corresponding potassium, ammonium (also made by Marignac) and zinc salts thus establishing, as he believed, the 4:10- series.

FORMATION OF THE 4:10- SALT.

The writer, in due course, succeeded in making the salt by the method of Gibbs', whose observations[11] tell the story quite well and may on that account be given here:

The general result of my own study of the action of acetic acid upon the neutral tungstate is that we obtain the 5:12, the 9:22, or the 4:10 salt, according to the circumstances of the case, the constitution of the salt formed depending mainly upon the degree of concentration of the acid and upon the duration of its action.

The indefiniteness confessed in this quotation indicates how easily one may be led astray in the preparation of the 4:10- salt.

In the experiments of the writer definite amounts of the constituent materials were used: 100 g. of $Na_2WO_4.2H_2O$ was dissolved in 140 cc. of water and 50 cc. of glacial acetic acid was gradually introduced into the solution; the flask was cooled under running water as it became heated. Beautiful white needles separated, but on recrystallisation from water the 4:10- and 5:12- salts were the products. Were the white needles not recrystallised, but simply washed with cold water, and then analysed, the result was: water, 13.62 per cent.; Na_2O, 8.17 per cent.; WO_3, 78.08 per cent.; approximating closely the requirements of a formula $9Na_2O.22WO_3.51H_2O$. Many similar trials gave like results, which would mean that the preceding conditions gave in reality two salts—4:10 and 5:12. Usually there was a preponderance of the first salt, the 4:10- salt, which Jules Lefort claims to have made by pouring a saturated solution of the normal salt into an excess of glacial acetic acid in the cold, when a white insoluble precipitate separated. This was collected, washed with alcohol, and then dissolved in boiling water. On cooling, it separated in very beautiful, transparent, oblique prisms, unalterable in the air. And yet this same chemist—Jules Lefort, p. 96 of the same Journal, advises that sodium bitungstate, $Na_2O.2WO_3.6H_2O$, is produced when glacial acetic acid is added (to acid reaction), to a saturated solution of normal sodium tungstate. After a day or two the salt was said to separate in long, prismatic needles. At least fifty experiments were made by the writer in the hope of obtaining this bitungstate. The working conditions in one trial will suffice to indicate the manner of procedure.

One hundred and fifty gr. of normal sodium tungstate was dissolved in 100 cc. of water. To this solution was added 15 cc. of crystallised (glacial) acetic acid in portions at a time of 0.5 cc. to 1 cc. The liquid warmed. When 13 cc. of acid had been added sodium acetate separated. After 72 hours the liquid was poured from the crystals adhering to the flask, and these were then washed four or five times with cold water, after which they were dissolved in warm water. In the course of a few hours crystals appeared. The water content of these was determined and found to be 14.10 per cent., approximating 14.02 per cent., the water content of the 5:12- salt. In the filtrate from these crystals a second salt appeared. Its analysis gave 12.86 per cent. of water, 8.45 per cent. of sodium oxide, and 77.67 per cent. of tungstic oxide, corresponding to the requirements of the 4:10- salt.

Thus it occurred in the many other experiments conducted with the greatest care. Gibbs, on following Lefort's suggestion, was "without success in any one instance, the results . . . being in all cases very different in composition." G. von Knorre[12] says: "I have twice tried to prepare this salt exactly according to Lefort's direction, but both times obtained the compound $5Na_2O.12WO_3.28H_2O$"; and Gonzales[13] adds his inability to confirm the work of Lefort.

(From the "Journal of the American Chemical Society," September, 1922.)

(To be continued.)

9 *Riche, Jahresber*, 1857, 189; *Ann. chim. phys.*, [3] 50, 5; *Jahresber*, 1856, 372.

10 *Ref. 1, p. 221.*

11 *Ref. 1, p. 226.*

12 *G. von Knorre, J. prakt. Chem.*, N.F., 27, 84.

13 *Gonzales, J. prakt. Chem., N.F.*, 35, 47.

HARDWOOD DISTILLATION.

By H. C. Merriam.

The green logs are first cut into 49-inch lengths, and then into 12-inch blocks. These are taken to predriers and dried by the waste gases from retorts in a counter-current. As a rule the approximate yield of alcohol is 1 gall. of 82 per cent. per cord of wood, although by careful regulation from 2-3 gallons have been obtained, and a ot depends upon efficient scrubbing. Chips and sawdust are more difficult to handle, and a process known as the Stafford process has been worked with success. Here, advantage is taken of the exothermic heat to maintain the desired temperature. Hardwood waste gives about the same yield of methyl alcohol and charcoal, but about 50 per cent. more acetic acid. When the wood is dried to a moisture content of 1-2 per cent., the acetic acid obtained is more concentrated, which renders subsequent evaporation an easier matter. A triple effect evaporator for the calcium acetate and the acid itself is attendant with many advantages. A serious competitor to the industry is the production of acetic acid from calcium carbide, but such competition is being etively contested by further research.

THE SOCIETY OF LEATHER TRADES CHEMISTS—BRITISH SECTION.

A meeting of the British Section of the S.L.T.C. was held at the Leathersellers' Technical College, 176, Tower Bridge Rd., London, S.E.1, on Friday October 6, 1922, at 10.30 a.m.

Agenda.

Minutes of last meeting.

Reports from Analysis Committees.

The estimation of Sulphides by means of standard zinc sulphate solution, Mr. W. R. Atkin, M.Sc.

The estimation of ammonia in lime liquors without distillation, and incidently the simultaneous estimation of caustic alkalinity, Mr. W. R. Atkin, M.Sc.

Water Soluble Matter in Leather. Its estimation and significance, Mr. J. R. Blockey, M.Sc.

The Sampling and Preparation of Leather for Analysis, Mr. J. R. Blockey, M.Sc.

EDUCATIONAL NOTES.

W. G. Foyle, Ltd., booksellers (new and second-hand), 121-125, Charing Cross Rd., W.C.2, have sent their latest catalogue of scientific books. It contains particulars of a large number of standard books. Students will do well by sending for a copy before making their purchases. The prices are mostly much below the published ones.

A division of the Chair of Mining at the University of Birmingham is announced. It has been held by Sir John Cadman, but in future there will be two professional chairs. One professor will be concerned with coal and metal mining, and the other will be wholly engaged with the department and school of petroleum and oil engineering. The school of oil engineering is very largely due to the large sum of money which has come to the University from the leading persons engaged in the oil industry in Great Britain, and it is the intention of the University to build up a great school of oil engineering which, with the exception of the work done at the Imperial College, London, will be the only such school in the British Empire.

GENERAL NOTES.

d- PIMARIC ACID.

Dr. E. Knecht and Miss E. Hibbert have published a preliminary note (*J. Soc. Dyers and Colourists*, 1922, p. 221) on the preparation of d- pimaric acid, M.P. 212° C. l- pimaric acid, from French rosin is dissolved to form the sodium salt. Hypochlorite solution is next added, and the mixture allowed to stand overnight. The crystalline mass is separated by decantation, dissolved in water, reprecipitated with H_2SO_4, and recrystallised from alcohol. This was found to be the most suitable method for isolating d- pimaric acid, and the yield is about 1[illegible]

THE INSTITUTE OF METALS.

As a result of the recent very successful meeting of the Institute held at Swansea, steps are now being taken to form a South Wales local section of the Institute in that town.

From the programme of meetings recently issued, we gather that the coming session will be a full one. The North-East Coast Local Section, with headquarters at Newcastle-on-Tyne, has for chairman the Hon. Sir Charles A. Parsons, K.C.B., F..RS., and for vice-chairman Professor H. Louis, M.A., D.Sc., A.R.S.M.

Prospective members, as well as existing members, are allowed to attend the meetings of the Institute and its local section.

Dr. W. Rosenhain, F.R.S., head of the Metallurgy Department of the National Physical Laboratory, Teddington, will deliver the May lecture of the Institute on May 2, 1923.

New Patents.

THIS list is specially compiled for the *Chemical News*, by Messrs. Rayner (Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

24753—Atack, F. W.—Manufacture of anthraquinine and derivatives thereof. Sept. 13.

24897—Chemical Engineering Co., Ltd.—Pro-

24897—Chemical Manufacturing Co., Ltd.—Process of producing *intimate mixtures* of substances and obtaining chemical products therefrom. Sept. 14.

24974—Galloway, H.—Pipes for use when immersed in chemical liquids. Sept. 15.

24854—Giescke, C.—Process of agglomerating mixtures of fine ore and fuel in shaft furnaces. Sept. 14.

Specifications Published this Week.

185137—Atack, F.—Anthraquinone dyestuffs.

185424—Sulman, H. L.—Treatment of ores con-

168866—Clem, Dr. R.—Process of filling pulp boilers with heated sulphite lye.

176770—Blanc, G. A.—Method for the separation of chlorides of aluminium and potassium present in mixed solutions obtained in the treatment of leucite.

Abstract Published this Week.

Chlorates; Hypochlorites.—Patent No. 183671.—An invention for the manufacture of chlorates and hypochlorites, *more particularly the former* of calcium or magnesium by chlorination of the corresponding hydroxide, and to the preparation of potassium chlorate therefrom, has been Patented by Mr. M. Wilderman, of 72, Fellows Rd., Hampstead.

A dilute suspension of calcium or magnesium hydroxide is chlorinated, to which fresh material is added from time to time, until a solution of chlorinated products of 60-64° Tw. is obtained. *For example, milk of lime containing about* 50gr. Ca (OH) in suspension is prepared in a mixer agitated by the *stirrers* and the valves, being closed is pumped to the top of two towers through which it descends into a vessel. A distributing-plate, together with ebonite-coated glass balls, serves to distribute the liquor and expose a very large surface to the action of the chlorine, while at the same time preventing the deposition of solid matters in the towers. Chlorine, of a suitable concentration, passes through the towers, entering at the base and leaving at the top. The liquid in the vessel is agitated by the *stirrer and returns by siphon into the mixer.* Thence it is again circulated through the towers. As the chlorination proceeds, *fresh lime* is periodically introduced into the mixer, through an inlet. The temperature during chlorination is kept below 70° C. by using diluted chlorine, and if necessary, by adding water to the liquor in the mixer. The product of the process, a solution of calcium chlorate and chloride, and possibly hypochlorite, of 60-64° Tw., is pumped from the mixer and filtered. If it is desired to *prepare potassium chlorate, potassium chloride* in an excess of 2 per cent. over the theoretical *amount is added, and the bulk of the chlorate* allowed to crystallize at atmospheric temperature. The mother liquor is diluted, if necessary, until there is present preferably 45-50 gr. calcium chloride in 100 gr. of water, when the liquor may be cooled to −20° C. to separate further quantities of potassium chlorate, without simultaneous separation of ice or of calcium chloride. It is convenient to connect the outlet of the apparatus *to a similar apparatus in which comparatively* fresh milk of lime is being treated.

Then when the liquor circulating in the first unit has been completely chlorinated, the valves are closed, and the partly chlorinated lime in the second unit is pumped into the mixer for treatment as described above. Preferably, however, the conveyance of liquor is avoided by reversing the order of the units, and conducting the chlorine first to the second unit and then to the first unit, *the mixer of which contains fresh* milk of lime. The chlorine mains are provided *with connections to enable this to be done.* The with connexions to enable this to be done. The process may be applied to the production of concentrated hyrochlorite solutions.

Messrs. Rayner & Co. will obtain printed copies of the published specifications, and forward on

THE CHEMICAL NEWS,

VOL. CXXV., No. 3262

MINERALS DEPOSITED BY BACTERIA IN MINE WATER.

OBSERVATIONS IN THE KIMBERLEY DIAMOND MINES.

At a meeting of the "Diamond Fields' Mining Institute," held in Kimberley on July 7th, 1922, with Mr. A. F. Williams, General Manager of De Beers Consolidated Mines, in the chair, Mr. John Parry, the Company's Chief Chemist, described some abnormal mineral deposits found in the De Beers Mine.

In November, 1917, several specimens of very unfamiliar looking minerals were handed into the Laboratory for analysis and report.

Although work had been carried on in this mine for at least 30 years prior to this date, nothing of a similar nature seems to have been observed before. Indeed, it was not until haulage operations had been discontinued for nearly ten years, viz., since 1908, that their presence had been noted at all.

In the Kimberley Mine, where mining operations had been curtailed for a briefer period than this, a few small specimens, identical in character and composition to some of those from the De Beers Mine, have been obtained from a small cavity in the walls of the shaft.

In all the other mines, where work has been maintained uninterruptedly, no such minerals have been known to occur.

It is important to note that all these minerals were found either in the shaft itself, or on the floor of certain levels closely adjacent to the shaft.

A very cursory inspection served to convince anyone familiar with the ordinary minerals found on the numerous working levels of the mine, of the unusual character exhibited by these particular specimens.

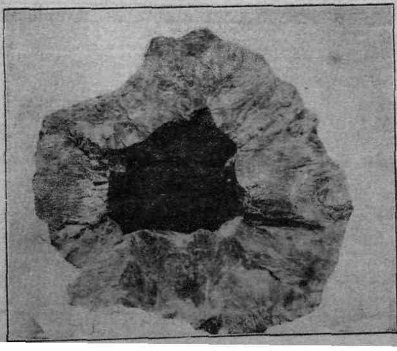
The samples chemically examined were as follows:—

No. 1.—A long cylindrical piece, which formed only a small portion of a huge deposit, found occupying the entire length of a vertical iron pipe, 180 feet long by 6 inches in diameter, erected in the Prospect Shaft of the mine, starting at the 1860 ft. level and terminating at the 2040 ft. level.

The exterior surface of the cylinder is of an entirely different colour to the mass of the core, being a dirty greyish white, while the mass is of a deep cinnamon brown. This surface, too, is rough and covered with innumerable shallow depressions; while the interior surface is brilliantly black and with peculiar undulatory oval elevations; *i.e.*, of somewhat botryoidal characters.

The *photograph* (*Fig.* 1) exhibits the cylindrical outline; and a *photograph* (*Fig.* 2) exhibits a good idea of the interior surface with the peculiar undulations.

The cylinder as shown does not represent the full thickness of this pipe core as originally found, for its total diameter is



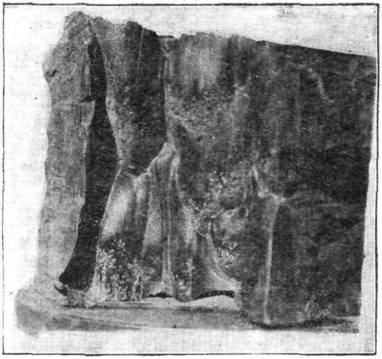


Fig. 3.

only $4\frac{1}{2}$ inches, while the full diameter of the pipe is 6 inches. Between this coloured portion of the core and the pipe wall was another inch or so of a *white* deposit. This white portion was rather soft and so loosely adherent that a vigorous tap with a hammer on the pipe easily detached it, and permitted of the ready removal of entire pieces of the solid core. None of this white portion was preserved by the miner who discovered the material. All that remains of it is the dirty white skin just alluded to. This remnant is not particularly soft and adheres pretty firmly to the rest of the core. Sufficient of it, however, was eased off for purposes of analysis.

The whole mass of the material is very brittle, and possesses a peculiar fibrous appearance.

Sample No. 2: This sample consisted of thin fragments of a scale which I collected ersonally on the 1,760 ft. level. The pieces were removed from the surface of some water lying in a depression on the floor of the tunnel. The whole surface of this water was covered with it as with a sheet of ice. There were many other pools and tunnels on this level, all similarly covered. In some there was a bulging of this surface coating, as though considerable pressure was being exerted beneath; while in others, there was evidence that this pressure had been great enough to fracture this surface skin, and the fractured portions, being of greater sp. gr. than the water, were found lying at the bottom of the liquid, and such portions, when taken from the water, could be fitted into the broken surfaces. The thickness of this skin averaged 1 millimetre. It was opaque and of a faint brownish tint, and very brittle.

The pressure alluded to was in all probability due to an accumulation of gas, but at the moment I had no means available for collecting any of it for analysis, and on a subsequent visit I found all the surfaces had been broken.

I was unable to obtain any definite information as to the length of time required for this solid skin to form on these pools, for though the mine had been idle for ten years, it was only when the miner (Mr. Waddington) was placed in charge, about seven months prior to my visit, that any observation was made as to the occurrence of this peculiar deposit. From his remarks I assume that possibly only several months were needed for their formation.

Composition of No. 2 Sample.

	%
Calcium Carbonate	87.75
Magnesium Carbonate	6.34
Silica	1.32
Iron Oxide and Alumina	0.66
Moisture	2.00
Organic Matter	1.92
	99.99

Sample No. 3: This sample also occurs as sheets covering pools of water. They are of equal thickness to Sample No. 2, but are of a uniform blood-red colour. Held before a *strong light they are semi-transparent* and of a homogeneous structure. Fragments measuring 12 x 10 inches were easily procured, and were not so brittle as Sample No. 2, and were strong enough to resist any gas pressure from beneath, as all the specimens met with were perfectly flat. The upper surface was fairly smooth, but here and there on the underside small clusters of minutely globular particles occurred, *identical* in composition to the sheets. In some places a second sheet had been formed immediately beneath the first in almost optical contact. The insertion of a knife blade, however, between the two sheets caused a clean separation.

These samples were found on the 2,040 ft. level only.

Composition of Sample No. 3.

	%
Calcium Carbonate	90.25
Magnesium Carbonate	5.46
Silica	0.44
Iron Oxide and Alumina	0.40
Moisture	0.72
Organic Matter	2.16
	99.43

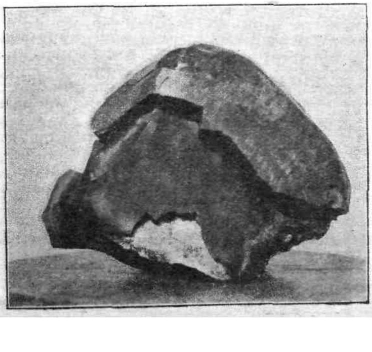
Samples No. 4: *These samples* are even more *remarkable than the pipe core* (*No.* 1). They consist of fragments of the tunnel rock (so called basalt), which have become coated while lying on the floor of the tunnel with the same deposit that occurs in the iron pipe.

The fragment illustrated in the *photograph* (*Fig.* 3), when first discovered, was as completely enveloped with the foreign material as an egg with its shell. The exposed surface of this, like the sample from the pipe, is brilliantly black, and perfectly smooth and glassy. The underside is only a little less bright than the upper, which is accounted for by its lying in contact with the dirty floor of the tunnel, and is also less smooth, as this surface shows an exact impress of the irregular ridges and depressions of the floor, as though it had been pressed down on it in a semi-solid condition, like a seal on warm wax. When this black coating was fractured, it was seen (as the photo shows very distinctly) that it consisted of two layers, though curiously enough the surface of the innermost layer was as brilliantly black and glassy as the outer one, and could be easily separated Evidently the deposition of the second coat must have occurred very long after the first.

The nucleus of another one of these samples, from which the black coating had been more completely removed, consisted of a piece of the tunnel rock (? basalt), 6 inches long by 2 inches wide, and varying from $\frac{1}{2}$ to 1 inch thick. It was very irregular in shape and angular.

The two coats varied in thickness: the lower between 1/16 to $\frac{3}{8}$ of an inch; the upper sometimes reaching $\frac{1}{4}$ of an inch. In spite of the angularity of this stone, the *outer surface of the complete specimen was* smooth and roughly dome shaped, entirely concealing the irregular shape of the internal fragment of rock.

Quite a large number of such specimens were found on this level (1,920 ft.), all ex-



hibiting a similar confluent-surface, and a double coating, and only differing from eahc other in size.

The occurrence of these deposits struck me as so anomalous that I was curious to see for myself the conditions under which they were discovered. Accordingly, accompanied by one of the laboratory assistants (Mr. Falck) and Mr. Waddington (the miner in charge), I descended this De Beers Mine in March, 1918. We descended the Prospect Shaft by cage to the 1,720 ft. level, and continued from that point by upright iron ladders to the 2,040 ft. level, spending some time at various levels on the way down. The most interesting of these levels was that at 1,920 feet. The portion of the tunnel immediately adjacent to the shaft was about 9 feet high and 14 feet wide. Here, on the floor, we came across the first samples of the black shiny deposit in the process of formation.

Scattered indiscriminately over the floor were fragments of the tunnel rock and pieces of wood tnd iron; some already completely enveloped in the black coating, others partially so, and again others showing the very initial stage of the deposition. And the source of all this abnormal formation was just water; water as it fell in intermitent drops from various parts of the roof. At first it appeared that this water was percolating through the rock from an upper level, but subsequent examination of the water afforded evidence that this could not be so. It was really derived from water rapidly streaming down the walls of the shaft itself, some of which, on reaching the opening of this level, would be carried along the roof between the innumerable minute ridges by capillary attraction, and fall ultimately and irregularly as drops. Beyond 6 feet from the shaft no drippings at all occurred, though the tunnel was composed of the same kind of rock for many yards further in.

Bottles were placed beneath the more rapidly falling drops, and a gallon of this water collected.

On analysis this water yielded the following data:

In parts per 100,000.

(a) *Bases and Acids*:

Calcium Oxide	3.08	parts
Magnesium Oxide	1.00	,,
Sodium Oxide	339.60	,,
Potassium Oxide	1.41	,,
Silica	2.70	,,
Iron Oxide & Alumina	1.70	,,
Carbon Dioxide	58.96	,,
Sulphur Trioxide	300.09	,,
Chlorine	34.00	,,
	742.54	
less Oxygen = to Chl.	7.66	
	734.88	

Organic matter also present.

(b) *Probable Combinations*:

Calcium Carbonate	5.5	parts
Magnesium Carbonate	2.1	,,
Sodium Carbonate	133.58	,,
Sodium Sulphate	532.65	,,
Sodium Chloride	53.98	,,
Potassium Chloride	2.69	,,
Silica	2.70	,,
Iron Oxide and Alumina	1.70	,,
	734.90	

The stone illustrated in the *photograph* (*Fig.* 3), and all the samples alluded to in No. 4, were picked up on this level, while the water was still dripping on to them. Here, too, the upper end of the pipe which had contained the core illustrated in Figs. 1 and 2, was exposed. Seven months prior to my visit this opening had been covered over with a plank, and during even that short period the continual dripping of the water had produced on its surface a thin deposit consisting of the same peculiar black material as upon all the other samples.

From this point we descended to the 2,040 ft. level by the iron ladder. Water was trickling down this ladder *continuously* and all the rungs were completely covered with the black deposit, the lowermost ones being perfectly smooth and extremely slippery. Portions of the coating were chipped off for analysis. At the bottom of the shaft (2,040 feet down), there lay a mass of contorted wire rope, which looked as if it were covered with molten pitch, so bright and black was it from long accumulation of this deposit.

THE SOCIETY OF CHEMICAL INDUSTRY.

Manchester Section.

"The Hydrogenation of Fats."

The Manchester Section of the Society of Chemical Industry held its first meeting for the session 1922-23 at the Textile Institute, October 6th. Dr. E. Ardern presided, and Dr. E. F. Armstrong, the President of the Society, was also present.

The Section is making a special effort to increase the membership of the Society, and for this purpose each member has been sent, with the annual agreement, a prospectus setting out the advantages of membership of the Society of Chemical Industry and also enclosing the usual form of application for membership. It is further pointed out th[illegible] now is the most suitable moment for [illegible]emists to join the Society, as the year commences in January, when the new Volume of Proceedings and Review commences.

The Chairman said that the next meeting would be a joint one, between the Manchester Sections of the Society of Chemical Industry, the Society of Dyers and Colourists, the Institute of Chemistry, and the Manchester Literary and Philosophical Society. They were fortunate in having Dr. F. W. Aston, of Cambridge, to come and speak to them about "Isotopes." Professor Bragg, as a representative of the Manchester Literary and Philosophical Society, would preside at the meeting. There was also something in the nature of an innovation to announce. A joint meeting had been arranged between the members of the Manchester Section and the Liverpool Section. This joint meeting would be held in Manchester, and a paper would be read by Dr. Levinstein.

It was hoped that next Session another joint meeting would be held in Liverpool. Reciprocity of that character could not but be helpful to the general interests of the Society, and also be very advantageous to the members of the two sections. There were now over 600 members in the section, and it was the opinion of the hon. Secretary that that number could be easily increased. No one need be frightened by the fact that the syllabus showed the list of ordinary meetings to be filled. The hon. Secretary would be quite willing, provided the Committee of the Section approved of the papers submitted, to arrange for additional meetings.

In introducing the President to the meeting the Chairman said they felt that Dr. Armstrong was admirably qualified to fill the Presidential chair, not only with distinction, but with the utmost possible credit to the Society. His high scientific atainments, his extreme originality of thought, and his keen business sense, a combination which has made him so eminent in the industry, could not but be extremely beneficial when applied to the general interests of the Society.

The President of the Society, Dr. E. F. Armstrong, F.R.S., then delivered an address, entitled, "PRACTICE AND THEORY IN AN INDUSTRIAL PROBLEM."

The main object of the few words I shall say to-night is to illustrate to you the extreme breadth of chemical problems, and the necessity for breadth both in the training and in the mind of the chemist if he is to succeed in his profession. The problem I have chosen is one which the force of circumstances has brought me personally closely into touch with, and therefore one which I do happen to know a good deal about. It is also a problem which I think is suitable for demonstration, and the problem is that of fat hardening, or, as it is known, the hydrogenation of fats. Dealing with the matter, in the first place historically, a laboratory investigation carried out by an eminent French savant, led to the discovery that if you pass certain organic substances together with hydrogen over finely divided metals, that reduction of these organic substances took place; that is to say, if they contained an unsaturated linkage that hydrogen was added to these linkages and they became saturated. That sort of fact was well known, or fairly well known, in connection with such metals as platinum and palladium, but it was a definite advance in our theoretical chemistry when nickel was found to have this power. Sabatier, who discovered this, naturally exploited the field as rapidly as he could. Among other things he tested the behaviour of the unsaturated fatty acids and fats towards this new reagent, with very indifferent success.

Then let us pass from the laboratory to that other class of chemist, the great class of people who are always trying to turn the facts which they read in the literature to profitable account. Among others, a certain Dr. Norman saw the bearing of Sabatier's observations on the fat industry. He tried very hard successfully to apply

Sabatier's discoveries. He found, as any of you will find in tackling a problem of such magnitude, with limited capital, that the difficulties on the chemical side were small but on the plant side very large. The process passed out of Dr. Norman's hands to that of a larger or more powerful firm, and they again found that, perfect as Dr. Norman's work had appeared to be, there was a very great deal to be done to gain more of a plant nature, of a chemical nature, before the process could be worked out.

I think it is illuminative to allude to some of those difficulties, because they will demonstrate the hundreds of ways in which the chemist has to exercise his ingenuity; how he has to be master of all trades, and how considerations of all kinds, in addition to those of the text book equations, enter into his daily life. Take the problem of fat hardening. Nothing could be simpler in theory: an unsaturated double bond, hydrogen and a catalyst, and you have your unsaturated fat. In practice, first of all, twenty or twenty-five years ago, hydrogen was only wanted in the laboratory, and on a small scale for balloons; that is to say, nobody knew how to make pure hydrogen in quantity cheaply. Therefore, the would-be hardener of fats had to find out how to make hydrogen. Electrolytic hydrogen was, of course, an attractive source, but on the other hand the costs of the plant, the prime costs, and the lack of any outlet for oxygen, which, of course, is formed at the same time, proved great difficulties in the way of making cheap hydrogen by that process. Alternate methods, acids on iron, and various methods, all broke down from the point of view of cost; and the only method which to the manufacturer seemed to promise success was that of taking water gas, which, roughly, is 40 per cent. CO. and 40 per cent. H. and getting rid of the CO. Now even the manufacture of water gas in those days, and that is not so very long ago, was in a very crude state. You could buy producers, but the life, and the repair cost, and so on, left much to be desired. Therefore, your would-be carrier-out of the chemical process found that, in the first place, is energies were dragged right back to what was almost a gas engineering, at any rate a chemical engineering, problem of his producer plant.

Well then the water gas problem—to get from that to hydrogen—there are obviously two methods of doing it; the one to scrub out the CO., which, of course, was developed by the Badische Company, the other to make use of the reaction between CO. and steam to give you CO_2 and hydrogen. That is done by passing your CO. over iron oxide, that is to say your water gas, to give you iron in the free state, and CO_2, stopping that current, and, running steam at a proper temperature over your iron; in that way decomposing the steam into hydrogen and iron oxide. You will carry out what I might call a cyclic reaction of that kind; first the passage of one gas, and then the passage of another gas, at the proper temperatures to get reaction. The hydrogen had to be free from the material that was fed in first, CO. All this presented problems of great difficulty. Originally, these problems were solved, more or less empirically, by dint of hard work on the part of the chemist on the spot, making practical, careful trials, and keeping data added by the engineer. In later days, the physical chemist has come to our assistance, and by a proper use of dynamics and various heat equations, and so on, has done much to facilitate the establishment of the ideal conditions of the laboratory. But, in the main, such work, valuable as it is, merely served to confirm the results which were arrived at empirically by the hard-working men on the spot.

Dr. Armstrong then dealt with the production costs of hydrogen, and stated that the electrolytic process of making hydrogen suffered from a high capital cost, unless it was carried out in a country with unlimited cheap water power. The relative commercial values of saturated and unsaturated oils were next discussed.

Dr. Armstrong then dealt at some length with the question of the catalyst, and the importance of obtaining a large surface area with the aid of pumice stone, kieselguhr, etc. The surface was very delicate and sensitive, and must be very carefully preserved, and there must be no over-heating of the catalyst. There was a wonderful literature based on catalyst poisons—and also a very wonderful jargon. It all amounted to this: that if anything acted injuriously on the surface the activity of the catalyst was reduced.

The hardening reaction took place quite fast. It was done in big vessels, a good many tons at a time. The determination of hardening value took some little time, and the determination of the melting point took a long time. The determination of

the refractive index, a physical method, was the only quick method.

The theory of the reaction was then dealt with by Dr. Armstrong, who illustrated his formulæ on the blackboard, and mentioned the work done by Lord Rayleigh, Hardy, Adam and Langmuir.

In conclusion, Dr. Armstrong said that work of the kind he had indicated could *only be done as the result of team work.* Team work could only be done as the result of the utmost loyalty, self-sacrifice and good feeling. His experience, limited as it was, had left him with a feeling that the training chemists received the analytical training, that was to say the training of suspicion had made them much less ready to mix together, much more critical of their fellow chemists, than was desirable in the best interests of the profession. He thought the greatest good the Society had been doing, was doing, and could do, was to keep on bringing them together in the most friendly way possible, in order that they all might understand what one another were thinking and doing.

The proceedings closed by the Chairman proposing a vote of thanks to Dr. Armstrong for his address.

BRITISH ASSOCIATION.

FUEL ECONOMY.

(*Continued from Page* 218.)

Another difficulty in testing cooking ranges and the like is the question of "residual heat." The heat capacity of any cooking range is considerable; when put into operation the structure at first absorbs a large proportion of the heat generated, which remains after the useful operations are discontinued, and is only gradually dissipated thereafter. In making calculations from the results of a given test, this "residual heat" cannot be ignored unless the cooking operations have been continuous and uniformly conducted throughout, but in ordinary practice the apparatus is rarely used in such a continuous manner. And as such "residual heat" is usually much larger in amount than the total quantity utilised, it is evident that the efficiency cannot fail to be low in any practical case, and will vary greatly according to the weight of the appliance and the length and extent of the cooking operations.

The determination of any true efficiency can only be made by raising the apparatus to, and maintaining it in, a "steady state" as nearly as possible, during which period valid observations on running efficiency can be made. It is, therefore, necessary to maintain the temperature as constant as possible over a long period in the steady state, and to integrate the entire results over a period of many hours.

The numerical results obtained during my experiments have in all cases been verified by the subsequent use of the same appliance in cooking a standard weighed menu, and there has been found to be a reasonably close correspondence between the fuel consumed during the practical operations and the figures experimentally determined.

The four principal sources of heat usable in cooking ranges are solid fuel, gas, electrical energy, and oil fuel. Fairly complete investigations have been made of solid fuel and gas, but electrical series are in progress at the time of writing, and cannot be spoken of with the same degree of confidence as in the other two cases. The oil methods have not been investigated at all.

Of these four, solid fuel is by far the most difficult to handle in an experimental sense. It is impossible to measure the instantaneous rate of combustion. This cannot by any means hitherto discovered be maintained as constant as is necessary for really accurate instantaneous observations, and to maintain a true "steady state" in which the temperature of the range itself is kept accurately constant from hour to hour is not possible. Results can only be obtained by prolonging the experiment and obtaining a final result by a process of integration.

When a charge, however small, of fresh solid fuel is added to a glowing fire, the resulting combustion is essentially variable. When the rate of stoking is maintained artificially uniform, this variation of the reading takes the form of cyclical variations only approximately of sine character. Another considerable difficulty relates to the intensity of the draught. The same total rate of combustion can be produced in a variety of different ways by varying simultaneously the thickness of the fire and the intensity of the draught. Each such combustion results in a variation in the observed result.

The measure of the combustion is effected by analysing the flue gases. It was found impossible, with a range as ordinarily constructed, to obtain any such value of the CO_2 content of the flue gases as

would correspond to really efficient operations with the ordinary commercial type of range. The general value showed that from eight to ten times the chemically necessary minimum of air was used. A high CO_2 value can only be secured by artificially suppressing the in-leakage of air. The value of the CO_2 content in any given appliance was found to be a correct measure of the efficiency.

With gas there are similar difficulties with regard to the surplus air, but not with regard to constancy of condition. With electricity there are no experimental difficulties, provided that the voltage of the supply is maintained constant.

Experimental Method.

Oven.—The interior temperature in an oven is a function whose significance is very small, for the following reasons: (1) the reading of the same thermometer in different parts of the oven varies widely; (2) several thermometers of different type, all correct, and all, therefore, reading the same, when immersed, for instance, in hot oil, take up widely different readings when placed together in the same oven, essentially because the temperature of any object placed in any conditions is such that the net time rate of gain or loss of heat is zero.

Heat is lost or gained by any such object by radiation and convection. The relative influence of these two in any given environment depends on the size, shape, and radiativity of the surface of the bulb. Apart from any question of dimensions, no measurements of efficiency by means of thermometer readings would, therefore, in any case be possible. There is, in fact, no such function as the "interior temperature," and the expression "mean interior temperature," is meaningless, except when its physical meaning is arbitrarily laid down. The only function to which this expression can reasonably be applied is the rate at which heat is transmitted to some extended object of conventional standard size, radiativity of surface and shape, placed in the oven, and of such size as to occupy a large part of the space. The exression "efficiency" can only have a definite meaning when the object to which heat is communicated is precisely defined in these respects.

Exhaustive trials were made with vessels of standard shape filled with water, by observing the rate of rise of temperature, and calculating the transmission therefrom.

This general method has the fatal disadvantage that great experimental difficulties are introduced, and with a large object in the oven having a rising temperature no sort of "steady state" can possibly be maintained. The efficiency also varies considerably according to the temperature of the object to which heat is communicated.

A more convenient calorimeter is a coil of blackened copper pipe, through which a uniform stream of water is maintained. Special devices were designed and made for maintaining constancy in the water flow. The water may be at any temerature for which the efficiency is required. The flow is regulated so that the rise in temperature between in-flow and out-flow is not great. The coil as a whole can be maintained at a constant mean temperature. This method has the great experimental advantage that one reading of the difference in temperature between in-flow and out-flow suffices to give the current rate of transmission, and the current variations in the thermal condition of the oven can, therefore, be determined.

The observed efficiency varies according to the temperature at which the coil is maintained. It is, therefore, necessary to lay down an arbitrary temperature at which all observations shall be made. If that temperature is high the resultant efficiency falls so low at low rates of combustion—even in extreme cases to zero—that its value cannot be accurately determined. As it is necessary to obtain a curve of efficiencies at all rates of combustion, it is, therefore, necessary to keep the mean temperature of the coil low, so that low rates of combustion may be included in the observations.

The temperature of the coil is of very great importance in the case of an ordinary gas oven. Where the temperature is low it enables the total heat of combustion to be brought into account; whereas when it is high the net heat only is available.

The use of gas enables much more accurate observations to be made, as a close approximation of the steady state is easily attainable by careful regulation of the rate of combustion. The latter can be controlled in the case of an oven so that any desired rate of transmission is maintained. In this case the principal difficulty is to determine how to deal with the difference between the gross and the net calorific value of the gas.

With a cold coil in the oven, a considerable part of the latent heat in the water vapour in the products of combustion may be communicated to the coil. The water appears as condensation on the surface of the coil, and drips down into the base. Thus obviously a portion of the latent heat is utilised. When the temperature is high there is no such condensation, and therefore no utilisation of this fraction of the heat of combustion. Whether and to what extent this latent heat is utilised in the actual cooking of an article of food it is impossible to say—probably some portion in the earlier stages, and later a re-evaporation of the same water originally condensed.

It will be evident that the efficiency as observed with this coil calorimeter will vary according to the surface area of the coil, or, what is the same thing, according to the size of the oven in which the coil is placed.

In order to compare, on a rational basis, ovens of different size, it was necessary to investigate the question of the variation of apparent efficiency according to the size of coil used, and to specify the standard loading for an oven of any given size. It was found that when an oven is loaded to its fullest practical capacity the surface of all the food is approximately half the surface of the oven plates. This was, therefore, laid down as the standard loading.

The final efficiency therefore determined uon was the ratio between (1) the heat communicated to a coil whose exterior surface was half the interior surface of the oven when kept a ta constant temperature, and (2) the amount of heat in the quantity of standard fuel burnt per hour. This function varies according to the rate of combustion, the efficiency increasing with increasing combustion. Its value was determined for three different rates, and a curve drawn through the three experimental points so obtained.

Hot Plate.—The efficiency in this case is the ratio of the maximum hourly amount of heat which can be communicated by the hot plate to ordinary cooking vessels to that in the fuel consumed per hour. This efficiency is fairly constant at all rates of combustion. The hot plate is covered with standard cooking vessels, each containing a weighed quantity of water, the rate of rise in which is determined.

Hot-water Supply.—This efficiency is the ratio between the heat communicated to the water in a weighed and measured cylinder and that in the fuel consumed. 20lb. of fuel are used for this test.

SUMMARY OF RESULTS.

The following table gives a summary of the usual values obtained by the methods outlined in the foregoing appendix. It is to be understood that the phrase "commercial" means a range or appliance as supplied by makers and used in an ordinary manner, and that the term "specially designed" refers to appliances designed by me for these tests which, though expensive in construction, are thoroughly practical in character.

SOLID FUEL APPLIANCES.

	Found Efficiency per cent.
Oven.	
Highest value with specially designed range	9.5
High values with commercial ranges .... from	4.0 to 5.0
Usual values with commercial ranges ... . from	2.0 to 3.0
Lowest value with commercial range	0.8
Hot-Water Supply.	
Highest value with specially designed semi-independently fired boiler	42.0
High values with commercial appliances .... from	15.0 to 20.0
Usual values with commercial appliances .... from	8.0 to 15.0
Lowest value with commercial appliance	4.8
Hot Plate.	
Highest value with specially designed appliance	21.0
High values with commercial appliances .... from	4.0 to 12.0
Usual values with commercial appliances .... from	2.5 to 5.0
Lowest value with commercial appliance	1.14

GAS APPLIANCES.

Oven.	
Highest value with specially designed oven	55.0
Highest value with commercial oven	38.0
Lowest value with commercial oven	17.0

Hot Plate.

Highest value with specially designed appliance	60.0
Highest value with commercial appliance	55.0
Lowest value with commercial appliance (old pattern)	17.0

Griller alone (excluding boiling vessel standing over griller).

Highest value with commercial appliance	19.0
Lowest value with commercial appliance	16.6

A. H. Barker.

[Contribution from the John Harrison Laboratory of Chemistry, University of Pennsylvania.]

THE SODIUM TUNGSTATES. I.

By Edgar F. Smith.

(From the "Journal of the American Chemical Society," September, 1922.)

(Continued from Page 222.)

Therefore, it would appear that Forcher's method and that of Gibbs were the best suited for the preparation of the 4:10- salt, although the writer found that if to 100 gr. of normal sodium tungstate, dissolved in 100 cc. of water, there be gradually added *formic* acid to a distinct acid reaction, there will appear, after 24 hours, an abundant yield of the 4:10- salt. His experience leads him to regard this procedure as superior to that in which acetic acid is employed. The 4:10- salt was the only product. The 5:12- and 9:22- salts were not observed, so that the 4:10- product could readily be obtained pure by one or more recrystallisations from water. It was also shown that Forcher's procedure was superior to that in which acetic acid, ordinary or glacial, was used.

It is interesting to note that Forcher[6] alludes to the fact that once, when endeavouring to make sodium metatungstate by adding tungstic acid to a boiling solution of the normal salt, his work was interrupted, and upon his return he found crystals which analyzed for the 4:10- salt. This was, too, the experience of the writer, who obtained a very abundant yield of 4:10- in this way. Indeed, the scheme offers a very simple method for the preparation of the latter salt.

The writer, on one occasion, added a calculated amount of tungstic acid (enough to yield the 5:12- salt) to a boiling solution of normal sodium tungstate. The liquid was filtered, and crystals separated. On analysis these showed 14.02 per cent. of water; 8.16 per cent. of Na_2O; and 77.82 per cent. of WO_3, in harmony with the requirements of the 5:12- salt.

In the determination of the tungstic trioxide in these various salts, Gibbs' modified Berzelius method was used. The sodium oxide was estimated both directly and by difference.[14]

Properties of the 4:10- Salt.

These have received scant notice. The common opinion is that the crystals of the salt are monoclinic in form. They effloresce rapidly in dry air, and upon resolution in water considerable heat is evolved. Their solubility is, according to Forcher, one part in 12.6 parts of water at 22°; according to Lefort, 100 parts of water at 15° dissolve 16 parts of the salt; according to the writer, 100 parts of water at room temperature dissolve 19 parts of the salt.

The specific gravity of the salt was found to be 4.3, the mean of three determinations.

The melting points of normal sodium tungstate, the 5:12- salt, the 4:10- salt, the 9:22- salt, and the sodium metatungstate were repeatedly determined with these results.

1. $Na_2O.WO_3.2H_2O$: 665°. The liquid fusion was colourless and transparent as water.

2. $5Na_2O.12WO_3.28H_2O$: 705.8°. The liquid was very yellow in colour. The cooled mass was crystalline and yellow in colour for quite a while after congelation.

3. $4Na_2O.10WO_3.23H_2O$: 680.8°. Again the liquid was yellow in colour and retained this colour until quite cold, when it was crystalline and white, with a faint blue tint.

4. $9Na_2O.22WO_3.51H_2O$: 683°. The liquid was yellow in colour, even after cooling.

5. $Na_2O.4WO_3.10H_2O$: 706.6°. The meta salt melted with comparative ease. The deep yellow colour of tungstic acid predominated both while it was liquid, and when the molten mass became solid.

If, for a moment, we arrange the salts referred to above as follows:

14. *Ref.* 1, *p.* 219.

(1)	(2)	(3)
$Na_2O.WO_3$	$5Na_2O.12WO_3$	$4Na_2O.10WO_3$
1:1	1:2.4	1:2.5
665°	705.8°	680.8°

(4)	(5)
$9Na_2O.22WO_3$	$Na_2O.4WO_3$
1:2.444	1:4
683.3°	706°

interesting conclusions are apparent. Among these it is plain that (1) and (5) represent the two extremes, and it is disappointing that the ratios between basic oxide and acid oxide as they would exist in $Na_2O.2WO_3$ and $Na_2O.3WO_3$, and as Lefort thought he had made evident, appear not to exist. v. Knorre, it is true, made $Na_2O.2WO_3$, by fusing together calculated amounts of sodium hydroxide and tungsten trioxide, but when the anhydrous body was brought into solution, the latter yielded no crystalline deposit, even upon protracted standing.[15] It is most regrettable that Lefort's experiences have not been confirmed by subsequent investigators. Probably all of these have overlooked some little step in the preparation process, though confident that they proceeded in accordance with the printed directions. Or, it may be that Lefort failed to note a step, to him trivial, but which if known might have aided later colleagues to confirm his observations, which are numerous and bear the imprint of careful work.

A further examination of the ratios of basic and acid oxides in the 5 salts, represented above, discloses that (4)—the 9:22-salt—has a ratio (base to acid) close to those of the second and third salts—the 5:12- salt and the 4:10- salt. The 9:22-salt we owe to Wolcott Gibbs. It resembles in some points the suggestion he gave for the production of the 4:10- salt. Indeed, the writer's product prepared in the manner of Gibbs, analysed as follows: H_2O, 13.75 per cent.; Na_2O, 8.08 per cent.; and WO_3, 78.19 per cent. These results would pass well for the requirements of a 4:10- sodium salt and, therefore, a doubt does come to mind as to whether the 9:22-salt is a distinct individual.

When Gibbs described the preparation of the 5:12- salt, according to Scheibler,[16] he cautiously added: "If the proportion of chlorhydric acid is just sufficient to give an onion-red reaction with litmus, crystals are obtained, which are either a combination or a mixture of equal molecules of the 4:10- and 5:12- salts. Their analyses agree closely with the formula $5Na_2O.12WO_3.4Na_2O.10WO_3.41H_2O$." Gibbs left this point undecided, although he did make a zinc salt by adding a cold solution of zinc sulphate to a cold solution of the 9:22-sodium salt. A precipitate formed at first and then redissolved, but when the zinc sulphate was in small excess white needles separated. These proved insoluble in water. They were dried for some time upon woollen paper. Their analysis led to the formula $9ZnO.22WO_3.66Aq$. Gibbs had found the zinc salt of the 4:10 series to have the formula $4ZnO.10WO_3.29H_2O$, while Gonzales[17] speaks of zinc *para*-tungstate as having the formula, $5ZnO.12WO_3.37H_2O$.

It crystallised in white needles. These formulæ added together would give the formula $9ZnO.22WO.63H_2O$, which differs from the 9:22 salt of Gibbs by only 3 molecules of assumed water of crystallisation.

It must, however, be said that whenever the writer made Gibbs' 9:22- sodium salt, he found upon its recrystallisation that the two salts, 5:12- and 4:10-, appeared, so that he is sceptical in regard to the individuality of the 9:22- salt.

In the extensive work, for so it was, made upon the action of acetic acid and normal tungstates, hoping that the bitungstate of Lefort would be found, it was noticed that the crystals which separated after solution in water and recrystallisation left a mother liquor which grew alkaline upon concentration. These alkaline liquors separated from 4:10- and 5:12- salts with eventually not a little sodium acetate, but the liquid from the latter had a yellow colour and gave the alkaline reaction to which reference has just been made. The thought was entertained that perhaps at the beginning, when acetic acid reacted with the normal tungstate, sodium bitungstate was really produced, and that in its solution hydrolysis occurred with the production of 4:10- and 5:12- sodium salts. Patiently, all mother liquors were evaporated, the separating salts removed from time to time, then finally the liquid was allowed to evaporate spontaneously, when cauliflower-like white masses separated.

15. *Ref.* 12, *p.* 27.
16. *Ref.* 1, *p.* 225.
17. *Ref.* 13, *p.* 51.

These were dissolved in little water and permitted to separate spontaneously. Their analysis showed that these residues were *nothing more than sodium hydrate mixed* with sodium tungstate, which must be regarded as hydrolytic products of the several sodium tungstates formed on acting with acetic acid upon normal sodium tungstate. At present this seems the only reasonable explanation of what evidently occurred during the process of concentration.

PROPERTIES OF THE 4:10- SALT.

On testing the 4:10- salt, in solution, with various metallic salt solutions, these behaviours were noted.

The addition of a cold aqueous solution of zinc sulphate produced a white precipitate soluble in a slight excess of zinc sulphate. From this solution, on standing, white needles separated in stellar aggregations. These were the 4:10- zinc salt described by Wolcott Gibbs.

Cadmium sulphate occasioned a white voluminous precipitation, insoluble in an excess of cadmium sulphate as well as in cold and hot water, thus differing from the zinc salt.

With cobalt sulphate and nickel nitrate precipitates appeared soluble in an excess of the precipitants. That with cobalt was quite granular.

A solution of zirconium oxychloride ($ZrOCl_2.8H_2O$) gave (in a solution of the 4:10- salt) a heavy, white and extremely gelatinous precipitate, insoluble in water and in an excess of the precipitant.

Lanthanum sulphate gave a white, insoluble gelatinous precipitate. This also occurred with praseodymium and neodymium nitrates. There was nothing remarkable about these products. They proved to be insoluble and were easily decomposed by nitric acid, even in the cold.

Uranyl nitrate gave a flocculent yellow coloured precipitate (with the 4:10- salt). It redissolved in a slight excess of the uranyl salt. The solution was filtered, when a white granular powder separated.

Ferric ammonium sulphate gave a curdy slightly yellow precipitate, insoluble in an excess of the precipitant.

Alum produced a copious, finely divided percipitate, which curdled on agitation. It proved perfectly insoluble.

Chromium potassium sulhate occasioned a precipitate. It was greenish-grey in colour, gelatinous and insoluble in excess of the reagent and also in large volumes of

Lead nitrate produced a white, gelatinous precipitate,- *insoluble in an excess of* the precipitant and also in hot water.

Hydroxylamine hydrochloride (in a solution of 4:10- salt) caused no precipitation.

With hydrazine sulphate a rather voluminous, somewhat flocculent, white precipitate appeared, insoluble in cold water, but dissolving rather freely in hot water, and was not soluble in an excess of hydrazine sulphate.

GENERAL NOTES.

THE UNITED STATES TARIFF.

PUBLICATION OF TEXT.

On Thursday, the *Board of Trade Journal* published the text of all those portions of the United States Customs Tariff which are of interest to merchants and manufacturers in this county. The dutiable list, and the free list will be given in full, and also the special provisions, which confer powers upon the President to vary the rates of customs duties, and to change the classifications, and also in certain circumstances to impose an "American Valuation" as a basis for assessing *ad valorem* duties. The clauses making changes in the Administrative Provisions will also be given.

Board of Trade,

10th October, 1922.

INDIAN INDUSTRIES AND LABOUR.

The August number of the *Journal of Indian Industries and Labour* contains two articles of special interest in connection with the question of the extent to which assistance and control by the State is desirable and justifiable in the field of industrial enterprise. The Hon. Mr. C. Y. Chintamani, Minister of Education and Industries in the United Provinces, deals with the subject in an article entitled, "The limits of State aid to industry," with special reference to the work of the Department of which he holds charge. Mr. A. Y. G. Campbell contributes the first part of an article on the functions of provincial departments of industries, in which the whole question of State assistance is exhaustively and carefully reviewed. Mr. Campbell speaks from experience, as he himself held for some years the post of Director of Industries in Madras, which may fairly claim to be the pioneer of organised State assistance to industry, and was recently placed

on deputation by the Government of India to study the subject in Europe.

In an extract from the Presidential Address delivered to the Mining and Geological Institute of India, in January, 1922, by Dr. Leigh Fermor, Officiating Director of the Geological Survey of India, the author describes in a convincing manner the practical utility of a State geological department. Dr. Fermor declares that in royalties alone the receipts accruing annually to the Provincial Governments and other owners of mineral rights in India, in respect of the eight most important minerals, excluding salt and saltpetre, amount to a minimum of 84 lakhs of rupees.

Mr. J. K. Mehta, Secretary of the Indian Merchants' Chamber and Bureau, gives a short account of the composition and functions of chambers of commerce in the United Kingdom, the United States of America the British Colonies, and the principal countries on the Continent of Europe. The author shows that the main characteristic which distinguishes the British from the Continental model is its complete independence of Government.

Probably little is known by the general public of the extent to which the owners of mills and factories in India have actually introduced measures to safeguard and improve the welfare of their employees. The account which Miss Broughton gives in this number of the *Journal* of the work which is being done to-day in furtherance of this object is distinctly encouraging.

The possibility of making a complete and accurate census of the industrial production of India has been receiving much attention for some time past. Those interested in the subject will find in the *Journal* an account of the manner in which such statistics are obtained in the United Kingdom, the United States of America and Canada, contributed by Rai Bahadur D. N. Ghosh, the officiating Director of Statistics. Mr. Ghosh's article gives the reader an idea of the extent of the organisation and of the expenditure required to enable a census of this nature to be carried out.

The *Journal* contains the usual summarised accounts of the activities of the Provincial Departments of Industries during the preceding quarter, while Mr. S. H. Jhabvala contributes under the heading of "Miscellaneous Notes" an account of the Bombay Working Men's Institute, which was opened by the late Sir Vithaldas Thackersey in February last.

BIRMINGHAM UNIVERSITY.

Birmingham University New Professorships.

Professor R. R. Thompson, who has held the office of Director of Lands and Mines in Trinidad, has been appointed the new professor of oil mining at the University of Birmingham. Twelve years ago he was a lecturer on the staff of Sir John Cadman at the University. The new professor of coal and metal mining is Professor K. N. Moss, until recently assistant professor. Sir John Cadman will continue to act as Honorary Adviser to the University on all mining subjects, and Dr. Haldane as Director of the Coal Mining Research Laboratories.

EGYPT.

Tenders Invited for Supply of General Stores.

His Majesty's Consul-General at Alexandria has informed the Department of Overseas Trade that the Egyptian Postal Administration at Alexandria are inviting tenders for the supply of general stores for the year 1923-24.

Tenders, on the proper form and accompanied by a deposit of 2 per cent. of the total value of the offer, will be received by the Egyptian Postal Administration at Alexandria up to noon on the 15th November, 1922.

The range of stores required is fairly extensive and varied, and includes mailbags, boots, fuel, ready-made furniture, hardware, house linen, rolling stock and accessories, steel stamps, special stationery, disinfectants, flags, paint, wicker work, housekeeping requisites, etc. The complete specification, together with conditions of tender and tender form, may be seen by United Kingdom firms interested upon application to the Department of Overseas Trade (Room 82), 35, Old Queen Street, London, S.W.1.

It should be noted that representation in Egypt is essential. The Department will be pleased to furnish to firms not so represented the names of United Kingdom firms who have Egyptian branches prepared to handle contracts on behalf of third parties. (Ref. 9212/1/FE/GP).

BOARD OF TRADE ANNOUNCEMENT.

Safeguarding of Industries Act. Part II.—No. 2 Order: Gas Mantles.

The Board of Trade have made an Order, which comes into force forthwith, applying

Part II. of the Safeguarding of Industries Act, to *Mantles for incandescent lighting and component parts thereof, whether finished or not, manufactured in Germany.* The effect of the Order which is published in the Statutory Rules and Orders series (Safeguarding of Industries (No. 2) Order, 1922), is to impose an import duty of 33⅓ per cent. *ad valorem* on the class of goods referred to, if manufactured in Germany.

In exercise of the powers conferred on them by Section 5 of the Act, the Board of Trade have directed that Certificates of Origin shall be required so far as concerns the class or description of goods covered by the Safeguarding of Industries (No. 2) Order, 1922, in the case of goods consigned from all foreign countries in Europe.

The necessary instructions have been issued to His Majesty's Consular Officers in the countries concerned, and the form of Certificate of Origin already prescribed by the Board of Trade in connection with the previous Order (No. 1) will be applicable.

Board of Trade,
7th October, 1922.

DIRECTORY FOR THE BRITISH GLASS INDUSTRY.

Preliminary Announcement.

The Council of the Society of Glass Technology has approved the preparation of a Directory for the British Glass Industry.

This Directory will contain the classified names of all firms, associations, societies, trade unions, educational and research institutions interested in the manufacture and wholesale supply of glass and glass articles, and in the supply of raw materials, platn and machinery to the industry.

It is hoped that the Directory will be published at the end of the year, and members of the Society will have the privilege of purchasing it at a reduced rate. The price will be announced in November.

ROYAL MICROSCOPICAL SOCIETY.

20, Hanover Square, W.1.

The session 1922—1923 opened with a conversazione on Wednesday, October 11, at the Examination Hall, 8-11, Queen Sq., Bloomsbury, W.C.1. A full programme of papers has been arranged for the monthly meetings from October to June, 1923. The Presidential address, by Professor Frederic J. Cheshire, O.B.E., F.Inst.P., will be delivered on January 17.

BOOKS RECEIVED.

An Introduction to the Chemistry of Plant Products, by Paul Haas, D.Sc., Ph.D., and T. G. Hill, A.R.C.S., F.L.S. Pp. viii. + 140. Vol. II. 1922. Messrs. Longmans, Green & Co., 39, Paternoster Row, E.C.4. 7s. 6d.

The Origin of Spectra, by Paul D. Foote and F. L. Mohler, U.S. Bureau of Standards. Pp. viii. + 250. 1922. The Chemical Catalog Co., Inc., 19, East 24th Street, New York, U.S.A. $4.50.

The Nitrogen Industry, by J. R. Partington, M.B.E., D.Sc., and L. H. Parker, M.A., D.Sc., F.I.C. Pp. xi. + 336. 1922. Messrs. Constable & Co., Ltd., 10 & 12, Orange Street, Leicester Square, W.C.2. 21s. net.

Grundzuge der Angewandter Elektrochemie, by Dr. Georg Grube. Pp. xi. + 268. 1922. Verlag von Theodor Steinkopff, Dresden and Leipzig. Unbound 8s. 4d., bound 10s. 3d.

The Microscope, by Conrad Beck. First Edition. 1921. Pp. 144. London: R. & J. Beck, Ltd., 68, Cornhill, E.C. 2s. 6d.

Researches on Cellulose, by Charles F. Cross and Charles Doree. Pp. x. + 253. 1922. Vol. IV. of the series "Cross and Bevan," 1910-1921. Messrs. Longmans, Green & Co., 39, Paternoster Row, E.C.4. 15s. net.

Theories of Organic Chemistry, by Dr. Ferdinand Henrich. Translated and enlarged from the Revised Fourth German Edition of 1921, by Treat B. Johnson and Dorothy A. Hahn, Ph.D. Pp. xvi. + 603. 1922. Messrs. Chapman & Hall, 11, Henrietta Street, Covent Garden, W.C.2. 30s.

Coal and Allied Subjects, by F. S. Sinnatt, M.B.E., M.Sc., &c., and Associates. Pp. 204. Compendium 1, 1922. Messrs. H. F. & G. Witherby, 326, High Holborn, W.C.1. 15s. net.

NOTE ON THE ATOMIC WEIGHT OF BORON.

By F. H. Loring.

Referring to the chemical atomic weight of boron, an early determination of this element revealed the value 11.0; a later determination by Smith and Van Haagen revealed the value 10.90; a still later determination by O. Hönigschmid and L. Brickenbach revealed the value 10.82.

Aston's research on the masses of the boron isotopes revealed the values 10 and 11. Referring to page 114 of Aston's book, "Isotopes," 1922, the mean mass, which should correspond to the chemical atomic weight determination, is estimated at 10.75 + 0.07.

Referring now to my scheme for calculating isotopes, *Chemical News*, April 16, 1920, vol. CXX., p. 181, or see vol. CXXI., p. 105, or "Atomic Theories," page 148, the following is given:—

Element.		$n \times$ He $a\ b\ c\ d$	Isotopes and Prop. No.		Mean and Exp. Mass.
B	=	$2 \times 4 + \quad 3 = 11$	$1^3 \times 11$	= 10.93	10.9
		$2 \times 4 + 1 = 9$	$3^5 \times 9$		

Correcting on account of the lower mass isotope being 10, and introducing the Hönigschmid value, the scheme becomes—

Element.		$n \times$ He $a\ b\ c\ d$	Isotopes and Prop. No.		Mean and Exp. Mass.
B	=	$2 \times 4 + \quad 3 = 11$	$3^3 \times 11$	= 10.77	10.82
		$2 \times 4 + \quad 2 = 10$	$2^3 \times 10$		

It will be seen that my value, 10.77, is in close agreement with both Aston's approximate mean value and that of Hönigschmid and Brickenbach.

In the above scheme, in which $3^3 = 27$ and $2^3 = 8$, the calculation is as follows:—

$$\begin{array}{r} 11 \times 27 = 297 \\ 10 \times \ 8 = \ \ 80 \\ \hline 35)\ 377 \\ \hline 10.77 \end{array}$$

NOTE ON THE ISOTOPES OF IRON.

By F. H. Loring.

The isotopes of iron are of considerable interest, as this element has the strongest (ferro-) magnetic property. Whether the mass values will have any significance in this connection is of course uncertain. It is now believed that the atomic number and the structure of the atom are determining factors: but, be this as it may, Aston has recently published in *Nature* (Sept. 2, 1922) the isotopes of iron, which are 54 and 56. These values agree with those of my isotopic scheme published in this Journal (1920, vol. CXXI., p. 105), of which the following is an excerpt from the table:—

Element.		$n \times$ He $a\ b\ c\ d$	Isotopes and Prop. No.		Mean and Exp. Mass.
Fe	=	$13 \times 4 + \quad 4 = 56$	4×54	= 55.78	55.84
		$13 \times 4 + 2 = 54$	$2^3 \times 56$		

Referring to Aston's experiment, there was some difficulty experienced in registering the 54 value, so that further confirmation of this discovery may be necessary before it becomes fully accepted.

NOTICES OF BOOKS.

(1) *Cours de Chimie Organique.*
(2) *Cours de Chimie Inorganique.* Par FRED. SWARTS, Troisième Edition, revue et augmentée. Pp. 674 and 734. Bruxelles: Maurice Lamertin, Editeur. 1921 and 1922. Price 45 fr. and 50 fr.

Professor Swarts' Textbooks of Organic and Inorganic Chemistry have now reached their third edition.

These volumes are not intended as complete treatises, but form courses of study in the two main branches of the Science.

Professor Swarts has followed the traditional methods of presentation of the subject and has dwelt upon the physico-chemical aspects of chemistry in both the organic and the inorganic volumes. In the essentially descriptive portions, the details are commendably brief but adequate.

Some sections are dealt with more fully and contain later information than others. Recent work on the Constitution of Atom, the Isotopes, and Catalysis, have been incorporated. The volume on organic chemistry does not appear to differ essentially from the preceding ones, but some of the recent developments are mentioned and other revisions have been made.

For students who wish to become familiar with scientific French the volumes are very suitable, being at the same time reliable textbooks for consultation on points of theoretical importance. J.G.F.D.

The Properties of Electrically Conducting Systems, by CHARLES A. KRAUS. Pp. 415. New York: The Chemical Catalog Co. Inc. 1922. Price $4.50.

During the past thirty years, a number of American scientists, including some of the foremost physical chemists of the day, have carried out a vast amount of experimental work upon Conducting Solutions.

Professor Kraus, who has himself done good research work in this branch of Physical Chemistry, has now collected much of the material and results of these extensive researches, which have hitherto remained obscure in the various journals and transactions of Scientific Societies.

But whilst the readers of Professor Kraus' volume will be impressed by the large amount of physico-chemical researches performed by American scientists, they cannot but regret that much valuable and cognate work on this subject by British and especially Continental chemists has been ignored.

Selection of matter was indeed inevitable and the author has given a good and clear account of the American researches upon the conductance of electrolytic solutions and the properties directly dependent thereon. Solutions in non-aqueous solvents receive very detailed treatment. Much of the book will be new to many readers. Previously unpublished matter, especially from the author's laboratory, is also incorporated.

This monograph, which is one of those issued under the auspices of the American Chemical Society, merits the careful attention of all Physical Chemists.

New Patents.

THIS list is specially compiled for the *Chemical News*, by Messrs. Rayner (Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

25377—Aguillon, J. E.—Recovering benzol contained in gas. Sept. 19.

25538—Asahi Glass Co., Ltd.—Process for application of colloidal magnesium silicate as a forcing agent of manure. Sept. 21.

25742—Barron, C. A.—Method of manufacture of a highly-concentrated aqueous solution of aluminium acetate. Sept. 23.

25694—British Cellulose and Chemical Manufacturing Co., Ltd.—Manufacture of artificial filaments, threads, etc. Sept. 22.

Abstract Published this Week.

Cellulose Derivatives.—Patent No. 183908.—A process for preparing Cellulose Derivatives has been patented by Messrs. Plausons', Ltd., of 17, Waterloo Place, Pall Mall, London.

Acetates, ethers, and phosphoric acid and sulphur compounds are prepared by subjecting cellulose to high speed mechanical disintegration, and treating the colloidal and highly dispersed cellulose so obtained with suitable chemical reagents, the disintegration is essentially effected in a grinding-apparatus such as the colloid mill described in Specification 179124, while employing a grinding speed of 1,000 metres per minute or higher. In examples, cotton is dispersed in water in the colloid mill until the particles have a diameter of 0.8 u, and then combined with o-phosphoric acid at a temperature of 30-50° C., and *preferably after the addition of a trace of sulphuric acid.* Alternatively, the phosphoric acid may be allowed to react during the dispersion of the cellulose. Dispersed cellulose is heated with *acetic anhydride and acetic acid* in the presence of codium acetate as the accelerator, and the acetic acid may be produced in the nascent state by means of sodium acetate and sulphonic acid; dispersed cellulose is heated with sulphur, preferably in the presence of caustic or carbonated alkali and at a temperature not exceeding 150° C., dispersed cellulose is mixed with methyl alcohol and hydrochloric acid gas introduced-a-methyl ether of cellulose is formed.

Messrs. Rayner & Co. will obtain printed copies of the published specifications, and forward on post free for the official price of 1s. each.

THE CHEMICAL NEWS,

VOL. CXXV., No. 3263

MINERALS DEPOSITED BY BACTERIA IN MINE WATER.

OBSERVATIONS IN THE KIMBERLEY DIAMOND MINES.

(*Continued from Page* 228.)

Samples of this black deposit were isolated from the (1) "pipe core," (2) "the stones," (3) the "plank of wood," and (4) the "iron rungs" of the ladder, and *separately analysed.*

The composition of them all is practically identical, as may be seen from the following results:—

	(1) Sample from Iron pipe. %	(2) Sample covering Stones. %	(3) Samples off plank of Wood. %	(4) Sample off Rungs of Ladder. %
Calcium Carbonate	82.56	89.5	89.0	88.6
Magnesium Carbonate	8.77	5.81	5.2	5.9
Silica	0.38	0.14	0.4	0.2
Iron Oxide and Alumina ..	2.80	0.14	0.28	0.8
Moisture	3.92	1.83	0.90	1.3
Organic Matter	1.71	2.66	1.56	2.6
Sodium Sulphate	trace	trace	2.55	trace
	100.04	100.08	99.89	99.4

Some contained traces of P_2O_5 and NH_3.

The weight of material found in the pipe was approximately estimated. The sp. gr. of the material was 2.6, and its average thickness 2 inches. The pipe was 6 inches in diameter, and its length 180 feet, the whole of which was coated internally with this deposit. Calculated out, this indicates a weight of 3.64 tons. There is at least 200 lbs. of it which consists of organic matter.

Reverting to the analysis of the water. which produced this deposit, it will be seen that the amount of Carbonate of Lime and Magnesia present is ridiculously small, and only exceeds slightly their actual solubility.

To produce this 3.64 tons of deposit. nearly 14 million gallons of this water would be required; and further, it would be necessary to evaporate it to complete dryness; and to accomplish this in 10 years would mean that 2½ gallons must be dissipated every individual minute. There exists the possibility that at various times during this period of ten years, that the lime content of these waters may have exhibited great fluctuations.

Unfortunately, no records are available of any analyses having been performed on these waters between 1908 and 1917. In 1906, however, Dr. Otto Hehner examined an alkaline water from this mine, and this showed only 6.2 parts $CaCO_3$ per 100,000.

Since 1917, at least six samples have been analysed, and at intervals of 12 months and 2 months; but the range was always low, varying from 1.2 parts up to, but never exceeding, 7.2 parts per 100,000.

It does not seem feasible that such rapid evaporation could take place in a vertical pipe of the specified diameter, and at a temperature only a few degrees above the normal, viz., about 20° C. Further, if the pipe were filled with flowing water, the evaporation would be negligible, while if it merely trickled through—which appears to have been the normal condition—there would certainly be *some* evaporation: but even assuming it to be so large as 10 per cent., no appreciable deposition of Carbonate of Lime would be induced from so weak a solution.

A reasonable conclusion here is that a theory depending wholely and solely on evaporation, is inadequate to account for so large a deposit in so short a time. Confirmation of this inference may be justified by the following instances:—

On the 1,600 foot level in the *Wesselton* Mine there is a 3-inch *horizontal* iron pipe, which has been delivering a stream of water into the main rock tunnel for the last seven

years, at the rate of 1,200 gallons per hour. It is not a mightily rushing torrent (for the pipe is always much less than half full), so that a large surface is continuously exposed to atmospheric friction, thus favouring evaporation. The amount of lime and magnesia in the water is nearly twice that of the De Beers sample. At least 73 million gallons of water, carrying 36½ tons of lime, have passed through that pipe in that period, and yet there is no appreciable deposition of lime in it at all. Here the conditions of flow and the lime content of the water are far more in favour of a copious deposit than in the De Beers case, and yet none occurs.

A second instance—at the Company's *Central Power Station*—the water used in the condenser has the composition shown below:—

Calcium Carbonate	2.59	parts per 100,000.
Magnesium Carbonate	0.77	,, ,, ,,
Sodium Carbonate	9.66	,, ,, ,,
Sodium Sulphate	8.38	,, ,, ,,
Sodium Chloride	27.48	,, ,, ,,
Silica, Iron Oxide and Alumina	3.29	,, ,, ,,
	52.17	

It varies a little from time to time. Say the average is 5.5 parts of lime per 100,000.

The average daily flow of this water through the condenser is 9,000,000 gallons. *The condenser has 4,000 tubes, and exposes* a cooling surface of 13,000 square feet. The *temperature reached is well over 38° C.*, and often reaches 60° C.—quite high enough to drive off nearly all the semicombined CO_2, which holds most of the lime in solution. Yet with all these favourable conditions for deposition, it takes 2 years for a scale one-fortieth of an inch to form. It amounts to only 0.13 per cent. of the total lime in solution.

If, in our De Beers Mine sample, then, the temperature of the water could have been maintained at 38° C., and had been flowing through a horizontal instead of a vertical pipe, it would only have yielded 9½ bl. of deposit instead of over 7,000 lb. That is, in the absence of any other contributory cause for the precipitation. That some other cause than evaporation was operating seemed to be very evident, though at the time I could not trace it, and the matter was *left in abeyance for some time.*

An opportunity subsequently presented itself for a further examination of the water causing the deposit. It was collected again as it dripped from the roof: it was quite clear and free from any suspended matter. The chemical characters of the dissolved ingredients *coincided with those of the original water.*

On this occasion, interruptions in the operations of analysis necessitated leaving the bottle with half its contents *undisturbed* for several days on the laboratory bench. It was then observed that all down the side remote from the light, a greyish white deposit appeared, which adhered most tenaciously to the glass. The bottom of the bottle was similarly coated, but with a *much thicker layer. The most violent agitation* of the bottle failed to disturb either of these adhesions. The bottle had remained securely corked all this time, so htat no evaporation nor loss of carbon dioxide could occur; and the fact should be emphasised, that when originally collected thte water was clear and free from any suspended matter.

The water was *poured off* and some of the greyish deposit scraped up for examination. When treated with dilute hydrochloric acid, the substance effervesced vigorously, and subsequent analysis showed it to contain a high percentage of carbonate of lime.

This was rather a phenomenal result. Here was a deposition of carbonate of lime occurring without any evaporation whatever; without any loss of carbon dioxide; *and with no chemical present to assist precipitation*; nor any increase of temperature; and yet it occurred in a homogeneous semi-transparent condition.

Naturally a microscopical inspection suggested itself. Several slides were prepared and viewed with a ¼-inch objective, and inspected very critically, for there at last appeared to emerge a hint suggesting an important contributory cause—perhaps the sole cause—in the formation of these weird deposits. *The field of view was occupied*

with myriads of living micro-organisms; some quiescent, but many more exhibiting considerable motility.

Both micrococci and bacilli were present, and it could be discerned, when viewed with special care, that each of the bacilli were surrounded with a transparent gelatinous envelope. It appears to me highly probable that it is the presence of this sticky jacket that enables these organisms to adhere so strongly to the glass of the bottle, or, for that matter, to anything else.

It would appear from this striking revelation that we have discovered a micro-organism capable of withdrawing calcium carbonate from solution and building it up into its own tissues *unaltered*: a sufficiently novel and startling inference.

If this inference, however, be justified, then it assists most materially in accounting for the accumulation of such phenomenal deposits, both in the pipe and on the stones, etc.

It occurred to us to ascertain if the coloured deposit from the stones and the pipe could yield any evidence that these particular bacilli might be lying dormant in this dry material. Some of the material was gently crushed; placed in a sterile test tube; covered with sterile water; the tube plugged with sterile wool, and then incubated for several days at a temperature of 21° C.

A similar tube, as control, was prepared under identical conditions, except that powdered native calcite was substituted for the coloured deposit, and incubated at the same time and temperature. After 5 days, portions were drawn off from each tube, and inspected microscopically. The "control" tube sample showed only calcium carbonate, nothing more; no living micro-organisma; neither bacilli, nor micrococci; but imagine our surprise and delight when the "deposit" sample revealed a crowd of living organisms, resembling those that had been obtained from the water itself: crowds of active micrococci and crowds of the tiny jacketed bacilli.

If these bacilli, then, be responsible for the extraction of calcium carbonate from the water, the adhesion of the deposit to the side of a vertical pipe does not now seem so surprising. For once a gelatinous colony of these organisms became attached to the pipe it was not easily dislodged; and the start once made, further accumulation was inevitable. The conditions of deposit and further growth were, in a way, ideal; there was darkness; there was a suitable temperature (about 70° F. on the average); there was organic matter in the water to serve as food; and there was calcium carbonate for tissue building; to put it in the crisp, brief way of the scientist, the whole conditions constituted a suitable nidus for the propagation of saprophytic organisms.

At this period of the investigation (in the absence of opportunities for further bio-chemical experimenting), this inference of bacterial agency struck me as being too audacious to serve as more than a tentative explanation. The work was left in abeyance for some time, but in *Nature* for August, 1920, there appeared the full address of the President of the British Association, Prof. Herdman, and in it appeared this remarkably apposite paragraph:—

"The part played by bacteria in the metabolism of the sea is very important, and probably of wide reaching effect, but we still know very little about it. A most promising young Cambridge biologist, the late Mr. G. Harold Drew, now unfortunately lost to science, had already done notable work at Jamaica and Tortugas, Florida, on the effects produced by a bacillus which is found in the waters of these shallow tropical seas and in the mud at the bottom; and which denitrifies nitrates and nitrites, giving off free nitrogen. He found that this Bacillus Calcis also caused the precipitation of *Calcium carbonate* on a large scale in the warm shallow waters. Drew's observations tend to show that the gerat calcareous deposits of Florida and the Bahamas previously known as "coral muds," are not, as was supposed by Murray and others, derived from broken up corals, shells, etc., but are minute particles of carbonate of lime, which have been precipitated by the action of these bacteria."

(To be Continued.)

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

(SECTION A.—MATHEMATICS AND PHYSICS.)

THE THEORY OF NUMBERS.

ADDRESS BY PROFESSOR G. H. HARDY, M.A., F.R.S., PRESIDENT OF THE SECTION.

I find myself to-day in the same embarrassing position in which a predecessor of mine at Oxford found himself at Bradford in 1875, the President of a Section which

is probably the largest and most heterogeneous in the Association, and which is absorbed by a multitude of divergent professional interests, none of which agree with his or mine.

There are two courses possible in such circumstances. One is to take refuge, as Professor Henry Smith, with visible reluctance, did then, in a series of general propositions to which mathematicians, physicists, and astronomers may all be expected to return a polite assent. The importance of science and scientific method, the need for better organisation of scientific education and research, are all topics on which I could no doubt say something without undue strain either on my own honesty or on your credulity. That there is no finer education and discipline than natural science; that it is, as Dr. Campbell has said, "the noblest of the arts"; that the crowning achievements of science lie in those directions with which this section is professionally concerned: all this I could say with complete sincerity, and, if I were the head of a deputation approaching a Government Department, I suppose that I would not shirk even so unprofitable a task.

It is unfortunate that these essential and edifying truths, important as it is that they should be repeated as loudly as possible from time to time, are, to the man whose interest in life lies in scientific work and not in propaganda, unexciting, and in fact quite intolerably dull. I could, if I chose, say all these things, but even if I wanted to, I should hardly increase your respect for mathematics and mathematicians by repeating to you what you have said yourselves, or read in the newspapers, a hundred times already. I shall say them all some day; the time will come when we shall none of us have anything more interesting to say. We need not anticipate our inevitable end.

I propose therefore to adopt the alternative course suggested by my predecessor, and to try to say something to you about something about which I have something to say. There is only one subject about which I have anything to say, and that is pure mathematics. It happens, by a fortunate accident, that the particular subject which I love the most, and which presents most of the problems which occupy my own researches, is by no means overwhelmingly recondite or obscure, and indeed is sharply distinguished from almost every other branch of pure mathematics, in that it makes a direct, popular, and almost irresistible appeal to the heart of the ordinary man.

There is, however, one preliminary remark which I cannot resist the temptation of making. The present is a particularly happy moment for a pure mathematician, since it has been marked by one of the greatest recorded triumphs of pure mathematics. This triumph is the work, as it happens, of a man who would probably not describe himself as a mathematician, but who has done more than any mathematician to vindicate the dignity of mathematics, and to put that obscure and perplexing construction, commonly described as "physical reality," in its proper place.

There is probably less difference between the methods of a physicist and a mathematician than is generally supposed. The most striking among them seems to me to be this, that the mathematician is in much more direct contact with reality. This may perhaps seem to you a paradox, since it is the physicist who deals with the subject-matter to which the epithet "real" is commonly applied. But a very little reflection will show that the "reality" of the physicist, whatever it may be (and it is extraordinarily difficult to say), has few or none of the attributes which common-sense instinctively marks as real. A chair may be a collection of whirling atoms, or an idea in the mind of God. It is not my business to suggest that one account of it is obviously more plausible than the other. Whatever the merits of either of them may be, neither draws its inspiration from the suggestions of common-sense.

Neither the philosophers, nor the physicists themselves, have ever put forward any very convincing account of what physical reality is, or of how the physicist passes, from the confused mass of fact or sensation from which he starts, to the construction of the objects which he classifies as real. We cannot be said, therefore, to know what the subject-matter of physics is; but this need not prevent us from understanding the task which a physicist is trying to perform. That, clearly, is to correlate the incoherent body of facts confronting him with some definite and orderly scheme of abstract relations, the kind of scheme, in short, which he can only borrow from mathematics.

A mathematician, on the other hand, fortunately for him, is not concerned with this physical reality at all. It is impossible to prove, by mathematical reasoning, any pro-

position whatsoever concerning the physical world, and only a mathematical crank would be likely now to imagine it his function to do so. There is plainly one way only of ascertaining the facts of experience, and that is by observation. It is not the business of a mathematician to suggest one view of the universe or another, but merely to supply the phpsicists with a collection of abstract schemes, which it is for them to select from, and to adopt or discard at their pleasure.

The most obvious example is to be found in the science of geometry. Mathematicians have constructed a very large number of different systems of geometry, Euclidean or non-Euclidean, of one, two, three, or any number of dimensions. All these systems are of complete and equal validity. They embody the results of mathematicians' observations of *their* reality, a reality far more intense and far more rigid than the dubious and elusive reality of physics. The old-fashioned geometry of Euclid, the entertaining seven-point geometry of Veblen, the spacetimes of Minkowski and Einstein, are all absolutely and equally real. When a mathematician has constructed, or, to be more accurate, when he has observed them, his professional interest in the matter ends. It may be the seven-point geometry that fits the facts the best, for anything that mathematicians have to say. There may be three dimensions in this room and five next door. As a professional mathematician I have no idea; I can only ask the Secretary, or some other competent physicist, to instruct me in the facts.

The function of a mathematician, then, si simply to observe the facts about his own hard and intricate system of reality, that astonishingly beautiful complex of logical relations which forms the subject-matter of his science, as if he were an explorer looking at a distant range of mountains, and to record the results of his observations in a series of maps, each of which is a branch of pure mathematics. Many of these maps have been completed, while in others, and these, naturally, the most interesting, there are vast uncharted regions. Some, it seems, have some relevance to the structure of the physical world, while others have no such tangible application. Among them there is perhaps none quite so fascinating, with quite the same astonishing contrasts of sharp outline and mysterious shade, as that which constitutes the theory of numbers.

The number system of arithmetic is, as we know too well, not without its applications to the sensible world. The currency systems of Europe, for example, conform to it approximately; west of the Vistula, two and two make something approaching four. The practical applications of arithmetic, however, are tedious beyond words. One must probe a little deeper into the subject if one wishes to interest the ordinary man, whose taste in such matters is astonishingly correct, and who turns with joy from the routine of common life to anything strange and odd, like the fourth dimension, or imaginary time, or the theory of the representation of integers by sums of squares or cubes.

It is impossible for me to give you, in the time at my command, any general account of the problems of the theory of numbers, or of the progress that has been made towards their solution even during the last 20 years. I must adopt a much simpler method. I will merely state to you, with a few words of comment, three or four isolated questions, selected in a quite haphazard way. They are seemingly simple questions, and it is not necessary to be anything of a mathematician to understand them; and I have chosen them for no better reason than that I happen to be interested in them myself. There is no one of them to which I know the answer, nor, so far as I know, does any mathematician in the world; and there is no one of them, with one exception which I have included deliberately, the answer to which any one of us would not make almost any sacrifice to know.

1. *When is a number the sum of two cubes, and what is the number of its representations?* This is my first question, and first of all I will elucidate it by some examples. The numbers $2 = 1 + 1$ and $9 = 2 + 1$ are sums of two cubes, while 3 and 4 are not: it is exceptional for a number to be of this particular form. The number of cubes up to 1,000,000 is 100, and the number of numbers, up to this limit and of the form required, cannot exceed 10,000, one-hundredth of the whole. The density of the distribution of such numbers tends to zero as the number tend to infinity. Is there, I am asking, any simple criterion by which such numbers can be distinguished?

Again, 2 and 9 are sums of two cubes, and can be expressed in this form in one way only. There are numbers so express-

ible in a variety of different ways. The least such number is 1,729, which is $12 + 1$ and also $10 + 9$. It is more difficult to fin da number with *three* representations; the least such number is

$$175,959,000 = 560^3 + 70^3 = 55^3 + 198^3 = 525^3 + 315$$

One number, at any rate, is known with four representations, viz.:

$$19 \times 363510$$

(a number of 18 digits), but I am not prepared to assert that it is the least. No number has been calculated, so far as I know, with more than four, but theory, running ahead of computation, shows that numbers exist with five representations, or six, or any number.

A distinguished physicist has argued that the possible number of isotopes of an element is probably limited because, among the ninety or so elements at present under observation, there is none which has more isotopes than six. I dare not criticise a physicist in his own field; but the figures I have quoted may suggest to you than an *arithmetical generalisation, based on a corresponding volume of evidence*, would be more than a little rash.

There are similar questions, of course, for squares, but the answers to these were fonnd long ago by Euler and by Gauss, and belong to the classical mathematics. Suppose, for simplicity of statement, that the nimber in buestion is *prime*. Then, if it is *of the form* $4m+1$, *it is a sum of squares*, and in one way only, while if it is of the orm $4m+3$ it is not so expressible; and this simple rule may readily be generalised so as to apply to numbers of any form. But there is no similar solution for our actual problem, nor, I need hardly say, for the analogous problems for fourth, fifth, or highe rpowers. The smallest number known to be expressible in two ways by two biquadrates is

$$635318657 = 158^4 + 59^4 = 134^4 + 133^4$$

and I do not believe that any number is known expressible in three. Nor, to my knowledge, has the bare existence of such a number yet been proved. When we come to fifth powers, nothing is known at all. The field for future research is unlimited and practically untrodden.

2. I pass to another question, again *about cubes, but of a somewhat different* kind. *Is every large number* (every number that is to say, from a definite point onwards) *the sum of five cubes?* This is another exceptionally difficult problem. It is known that every number, without exception, is the sum of nine cubes; two numbers, 23 (which is $2.2^3+7.1^3$) and 239, *actually require so many.* It seems that there are just fifteen numbers, the largest being 454, which need eight, and 121 numbers, the largest being 8042, which need seven; and the evidence suggests, forcibly that the six-cube numbers also ultimately disappear. In a lecture which I delivered on this subject at Oxford, I stated, on the authority of Dr. Ruckle, that there were two numbers, in the immediate neighbourhood of 1,000,000, which could not be resolved into fewer cubes than six; but Dr A. E. Western has refuted this assertion by resolving each of them into five, and is of opinion, I believe, that the six-cube numbers have disappeared entirely considerably before this point. It is conceivable that the five-cube numbers also disappear, but this, if it be so, is in depths where computation is helpless. The four-cube numbers must certainly persist for ever, for it is impossible that a number $9n+4$ or $9n+5$ *should be the sum of three.*

I need hardly add that there is a similar problem for every higher power. For fourth powers the critical number is 16. There is no case, except the simple case of squares, in which the solution is in any sense complete. About the squares there is no mystery; every number is the sum o four, and there are infinitely many which cannot be expressed by fewer.

3. I will next raise the question *whether the number* $2^{137}-1$ *is prime.* I said that I would include one question which did not interest me particularly, and I should like to explain to you the kind of reasons which damp down my interest in this one. I do not know the answer, and I do not care greatly what it is.

The problem belongs to the theory of the so-called "perfect" numbers, which has exercised mathematicians since the times of the Greeks. A number is perfect if, like 6 or 28, it is the sum of all its divisors, unity included. Euclid proved that the number

$$2^m(2^{m+1}-1)$$

is perfect if the second factor is prime; and Euler, 2,000 years later, that all *even* perfect numbers are of Euclid's form. It is *still unknown whether* a perfect number can be odd.

It would obviously be most iñteresting to know generally in what circumstances a number 2^n-1 is prime. It is plain that

this can only be so if n itself is prime, as otherwise the number has obvious factors; and the 137 of my question happens to be the least value of n for which the answer is still in doubt. You may perhaps be surprised that a question apparently so fascinating should fail to arouse me more.

It was asserted by Mersenne in 1644 that the only values of n, up to 257, for which 2^n-1 is prime are

2 ,3, 5, 7, 13, 17, 19, 31, 67, 127, 257;

and an enormous amount of labour has been expended on attempts to verify this assertion. There are no simple general tests by which the primality of a number chosen at random can be determined, and the amount of computation required in any particular case may be quite appalling. It has, however, been imagined that Mersenne perhaps knew something which later mathematicians have failed to rediscover. The idea is a little fantastic, but there is no doubt that, so long as the possibility remained, arithmeticians were justified in their determination to ascertain the facts at all costs. "The riddle as to how Mersenne's numbers were discovered remains unsolved," wrote Mr. Rouse Ball in 1891. Mersenne, he observes, was a good mathematician, but not an Euler or a Gauss, and he inclines to attribute the discovery to the exceptional genius of Fermat, the only mathematician of the age whom anyone could suspect of heing hundreds of years ahead of his time.

These speculations appear extremely fanciful now, for the bubble has at last been pricked. It seems now that Mersenne's assertin, so far from hiding unplumbed depths of mathematical profundity, was a conjecture based on inadequate empirical evidence, and a rather unhappy one at that. It is now known that there are at least four numbers about which Mersenne is definitely wrong; he should have included at any rate 61, 89, and 107, and he should have left out 67. The mistake as regards 61 and 67 was discovered as long ago as 1886, but could be explained with some plausibility, so long as it stood alone, as a merely clerical error. But when Mr. R. E. Powers, in 1911 and 1914, proved that Mersenne was also wrong about 89 and 107, this line of defence collapsed, and it ceased to be possible to take Mersenne's assertion seriously.

The facts may be summed up as follows. Mersenne makes fifty-five assertions, for the fifty-five primes from 2 to 257. Of these assertions forty are true, four false, and eleven still doubtful. Not a bad result, you may think; but there is more to be said. Of the forty correct assertions many, half at least, are trivial, either because the numbers in question are comparatively small, or because they possess quite small and easily detected divisors. The test cases are those in which Mersenne asserts the numbers in question to be prime; there are only four of these cases which are difficult and in which the truth is known; and in these Mersenne is wrong in every case but one.

(*To be Continued.*)

THE SOCIETY OF DYERS AND COLOURISTS.

The Manchester Section of the Society of Dyers and Colourists held its first meeting of the session on Friday, October 13th.

Mr. Pennington moved a vote of thanks to the retiring Chairman (Dr. Knecht), for his services to the section during the previous two years, and this was seconded by Mr. Hannay, and carried unanimously.

The newly-elected Chairman (Mr. William Marshall, J.P., F.I.C., F.C.S.), then took the chair, and delivered his inaugural address.

"THE DYEING AND FINISHING OF RAMIE."

In opening his address, Mr. Marshall said that the ramie fibre was again exciting considerable interest in many parts of the world, and dyers would probably in the near future be called upon to handle large quantities of it. He thought it might be of interest to members of the Society if he brought to their notice some results which he obtained in March, 1919, and at subsequent dates.

Dr. Marshall then gave a brief resumè of the preparation of the fibre previous to the dyeing process and the finishing process, showing specimens from the different stages of such preparation. China grass, ramie, or Rhea belonged to the natural order Urticaceæ, and hence was not a grass at all, but a species of nettle somewhat resembling in appearance and habits of growth the common nettle of Europe. It was, however, a stingless, or shooting, nettle of the sub-division Bœhmeria. There were many varieties of the plant, but only two species of interest for their fibre yielding properties, namely: (1) Bœhmeria nivea

(white-leafed ramie), which was first known and cultivated from time immemorial under the name of Tchou Ma; and (2) Bœhmeria Tenacissima (green-leafed ramie), known in India as Rhea and in the Malay Islands as Ramie. The plant was a shrub reaching 4 to 6 ft., and, in some cases, 8 ft. in height, very hardy and of rapid growth, yielding 3 or 4 crops a year without re-planting. It was easy of cultivation, and practically unlimited quantities could be grown in China, Formosa, Japan, India, Malaya, Queensland, Mauritius, Cameroons, West Indies, Brazil, Mexico, and the Southern States of America to meet all possible requirements. The plant had also been grown at Kew. Attempts to utilise the ramie fibre in this country date back to the year 1814.

After the plants are cut down, the first process was the removal of the outer bark, and the separation of the bast fibres in the form of ribbons, which were then hung up to dry. A small portion at the heart of the plant was waste, as it was pithy and useless. In China the stems, as soon as cut down, are soaked in water, and the bark scraped off by native women and children with a knife or ring, or the fingers, the bast fibres being cleaned and dried in the sun. The product was the China Grass of Commerce. A mechanical method of decorticating would be of immense value, and the inventors, stimulated by the offer of the Indian Government in 1869 and 1889 of a prize of £5,000, had devoted a great deal of attention to the subject, both in Europe and America. If a machine could be made which would turn out large quantities, and would not damage the strength and other good qualities of the ribbon, the cost would be lessened, and regular supplies insured. Some machines were said to be working satisfactorily in the U.S.A., and owing to these machinery improvements there were signs that ramie would be obtainable in the raw state much cheaper, and it might prove a source of money-making to cotton manufacturers.

According to the last report of the British Cotton Industry Research Association, they had some 300 cotton plants at the Shirley Institute, Didsbury, and he (Mr. Marshall) intended to suggest to the Association that it would be useful to add a few ramie plants to their collection, so that engineers might study at first hand its properties and work out the problem of cheap and satisfactory decortication.

Most of the impurities were removed in the degumming process, and the resulting product was practically cellulose, almost identical in chemical constitution with bleached cotton and linen. The degummed fibre had most valuable properties. It ranks first of all the vegetable fibres (cotton flax, hemp, jute) in strength and durability. It was also the least affected by moisture and the atmospheric conditions, and was exceptionally white in colour, and the fibres were almost equal to silk fineness. It had a high silky lustre quite equal to linen in daylight. In artificial light it was certainly superior, and it was more hygienic than flax, hemp, or cotton, and washed better. On the other hand, flax was more uniform in length of staple, and less variable in the thickness of its individual fibres. Ramie lacked the elasticity of wool and silk and the flexibility of cotton. Yarns made from it had a tendency to be hairy, which diminished their lustre, and they had not the same smart appearance as when made from flax. This hairiness was due to the fact that the individual fibres lacked cohesion, and did not adhere to each other, as was the case with other fibres. It would not bend readily at right-angles like cotton, and unless it had been carefully treated it had a tendency to break. The fibres were frequently very broad, and at these parts were flat and ribbon-like in form, but were never twisted like the cotton fibre.

In strength and fineness the fibre equalled the best known fibres, but there was the peculiar hairiness in it, which, while enabling it to work with wool rendered it difficult to spin alone on account of its stiffness and lack of elasticity interfering with the twist, thus rendering the yarn tough, although the individual filaments had not lost their silky smoothness. These spinning difficulties had, however, been overcome, and all counts of yarn were now being produced in this country.

Broadly speaking, the coarser counts of ramie were made into ropes. The inferior qualities were utilised for the manufacture of string and fishing nets. The best counts were used for textiles, either alone or mixed with other fibres. During the last 60 years few practical problems had consumed so much time, energy and capital, as the attempt to bring China grass into use for manufacturing purposes. Some French, Japanese and Chinese silk goods are said to contain a proportion of ramie.

In China it is extensively used for mak-

ing cloth, especially the kind of cloth called "The white Summer cloth." This is a very fine material, made from the best fibre and most durable. The Chinese often wear clothes made from this grass cloth for 20 and more years; they have them dyed several times and then consider them as new clothes.

The resistance to the influence of the weather of the Chinese ships' sails made from grass cloth was well known. It was sometimes used in making sails for racing yachts when expense was no consideration.

Ramie could not be expected to take the place of ordinary cotton goods on account of its price, but for specialities and novelties there might be many openings where its valuable properties could be utilised. A good illustration of this was found in the manufacture of incandescent mantles, which were first made from cotton yarn. These were not satisfactory as regards luminosity, and had a tendency to break. Ramie was tried, and is now the principal yarn from which mantle fabrics are knitted and woven. Before the war large quantities were imported from Germany, the British makers only being able to produce a small percentage of the mantle manufacturers' requirements. The deficiency had now been made good, and British spinning plants which had rendered the country self-supporting in this respect were also able to meet all enquiries for other purposes. Mantles made from China grass had a higher and better maintained illuminating power, and were more capable of withstanding shock.

Mr. Marshall then dealt with the dyeing properties of ramie; in view of the many contradictory statements which had been published about difficulties in dyeing and fastness to light and washing. His results were conclusive that ramie was equal in all these points to cotton and flax. Direct, basic, developed, sulphur, vat, indigo, turkey red, anilin black, para red, and azoic dye-stuffs were used, and comparisons between cotton, ramie and flax were exhibited. Specimens of cloth in various finishes made from ramie and mixtures in both the mercerised and non-mercerised states were also shown in white, colours and prints, and were characterised by their softness, lustre and silky appearance.

In concluding his address, Mr. Marshall referred to the export of ramie from China, and the enormous demand for it from Japan, which was now taking something like 90 per cent. total quantity from China. This, of course, meant that the world was getting 10 per cent. This was a most unsatisfactory state of things. If the manufacture of ramie fabrics was to be successfully accomplished in this country, it could only be by the application of the best technical skill, and the close and hearty co-operation of the Lancashire manufacturers with spinners, dyers, and finishers. In his opinion, there was no reason why Lancashire should not produce from ramie many novelties which would have a ready sale in the markets of the world.

Mr. Huebner proposed a vote of thanks to Mr. Marshall for his address, and in seconding the proposition Mr. Hannay said it would be interesting to learn what the Japanese were doing with all the ramie they obtained from China. Japan was a country which, in textiles, was very well worth while watching if Lancashire was to keep its end up.

THE FARADAY SOCIETY.

ETHYL CHLORIDE, C_2H_5Cl.

By C. F. Jenkin.

(*A Contribution to a* GENERAL DISCUSSION *on* "THE GENERATION AND UTILISATION OF COLD," *held by the Faraday Society and the British Cold Storage and Ice Association on Monday, October 16th,* 1922.)

Ethyl chloride is a colourless liquid a little lighter than water; as its boiling point at atmospheric pressure is 12.5° C., it may be handled in open vessels without much loss, and may be stored in glass bottles or cylinders of quite moderate strength.

It is an anæsthetic, but must be inhaled in considerable strength before it has appreciable effect.

It is very inflammable, and considerable care must be exercised to avoid fires.

It is a very convenient material for refrigeration; the following data indicate its properties as a refrigerant:—

Latent heat at 0° C. = 93.7 cal. per gram, or C° lb. per lb.
Specific heat of liquid = 0.348 at - 30° C. to 0.413 at + 40° C.
,, ,, ,, gas = 0.22 to 0.28.

,, ,, ,, gas (saturated) at + 20° is 297 c.c. per gram.
at - 20° is 1305 ,, ,, ,,

The critical point is 190° C. and 54 atmospheres.

The vapour pressure curve is shown in the accompanying figure.

It does not attack metals, but for some reason not yet fully explained, the liquid does contaminate mercury, so that mercury manometers can *only* be used for pressures less than the vapour pressure corresponding to the room temperature—*i.e.*, roughly for pressures less than atmospheric.

It attacks india-rubber, but vulcanised rubber tubing and corks can be used, though they leak a little. They swell considerably, but return to their original size when the ethyl chloride dries off. Pure rubber tape is softened almost to soluton. Vulcanite swells moderately. It causes most woods to swell, but lignum vitæ can be used for valves, etc., when a non-conductor of heat is required. Bakelite is also useful as a non-conductor; it only swells very slightly.

Liquid ethyl chloride dissolves a small quantity of water, but can be dried by passing it through calcium chloride drying tubes. With water it forms very remarkable ice crystals; if a shallow glass of ethyl chloride is exposed to the air, it dries up and rapidly falls in temperature, and ice crystals form round the edge, condensed from the atmospheric moisture. These crystals appear to be tubular and grow rapidly, the ethyl chloride soaking up inside them as in a sponge. Similar crystals form at the throttle valve in a refrigerating machine if there is any water dissolved in the ethyl chloride and quickly choke the valve. It is important, therefore, to keep thte material dry in refrigerating plants.

Ethyl chloride is a convenient cooling material for use in laboratories; when sprayed on to any object the temperature is quickly reduced to $-20°$ C. or lower.

For mechanical refrigeration ethyl chloride is very suitable. The vapour compression cycle is the one used. The pressures corresponding to the ranges of temperature commonly required are very low, for example for a range of $\pm 20°$ C., the pressures are 19.4 and 3.5 lb. per sq. in. absolute; the compressor therefore works with a moderate vacuum on the suction side. The type of compressor generally used is a rotary pump (of the Roots Blower type). Oil being soluble in ethyl chloride cannot be used for lubrication, so pure glycerin is employed; this separates out by gravity without difficulty. The only serious difficulty in designing the plant is to make certain of avoiding leaks on the low pressure side; all air leaking in accumulates in the condenser and has to be purged from time to time. To avoid air leaks all valve spindles, compressor shafts, etc., have to be sealed with glycerin, so that any leakage is of glycerin, not air.

Owing to the low pressures, the volume of the pump and the cross sections of the pipes are enormously larger than those in carbonic acid or ammonia plants. On the other hand the strength required is very little, which makes the machinery very safe.

Reciprocating pumps are not suitable for compressors because the piston rod, which is lubricated with glycerin, carries moisture into the pump every stroke. The writer has had great difficulties with his research plant from this cause.

The inflammability of ethyl chloride is its most serious drawback. To get over this various "non-flam ethyl chlorides" have been put on the market. These are mixtures of ethyl chloride with large proportions of ethyl bromide. The mixture is not only non-inflammable, but may be used as a fire extinguisher. Its properties as a refrigerator are not very different from those of ethyl chloride, but as it is heavier than glycerin, special separators are necessary.

Impure ethyl chloride is supplied for refrigeration; it contains a small proportion of methyl chloride which may be slightly advantageous, as it raises the vapour pressure.

The writer is carrying out a complete investigation of the thermal properties of ethyl chloride for the Food Investigation Board (Department of Scientific and Industrial Research) and complete θ-ϕ and I-ϕ charts will shortly be published.

The following communication on the measurement of low temperature was made at the same meeting by Prof. C. R. Darling.

Amongst practical devices for the measurement of low temperature, the convenience of a thermal junction, coupled to a suitable indicator is apt to be overlooked. Some years ago, when engaged upon the determination of the congealing points of certain oils and other liquids, I had constructed the instrument now shown, which consists of a flexible couple of Hoskins' alloys, and a portable indicator of the pivoted, moving-coil type. Correction for changes in the temperature of the atmospheric junction may be made by adjusting

the pointer so that its position on the scale coincides with the reading of a mercury thermometer inserted in the lid of the indicator. The scale was calibrated at the National Physical Laboratory, the lowest reading being - 200° C., and the apparatus proved quite satisfactory in use. Its advantages over a pentane thermometer were that it responded more quickly to changes in temperature, and could be used in metal vessels and enclosures under conditions in which the readings of a pentane thermometer would not have been visible. A recent check of the calibration at the temperature of solid carbon dioxide showed that the instrument had maintained its accuracy. From this experience, I suggest that the thermo-electric method of measuring low temperatures might with advantage be applied in many cases where other methods are now in use.

As a means of determining the temperatures of the different parts of a large cold store, the resistance thermometer is the best at present available. When a number of these are brought to a switchboard, and arranged so as to be capable of connection to a common indicator, much care is needed i nthe choice of proper materials if good results are to be secured. Recently, when going through a large cold store in London, operated by ammonia refrigerators, I observed that the switchboard was located in a small office in the engine room, in an atmosphere smelling perceptibly of ammonia. The fittings on the switchboard, being constructed of brass lightly nickel plated, showed very marked corrosion, and the instrument was out of action. As an installation of this kind is expensive, every care should be taken to avoid mistakes of this kind, which tend to bring discredit on a very useful method of measuring these temperatures, and serve to prevent its more extensive use.

THE INSTITUTION OF RUBBER INDUSTRY.

Manchester Section.

The second meeting of the session of the Manchester Section of the Institution of Rubber Industry was held at the Midland Hotel on Monday, October 17th, Mr. H. W. Hatton presiding. There was a large attendance of members.

"Symbolic Rubber."

By Mr. D. F. L. Zorn (Chairman of the Rubber Shareholders' Association.)

Mr. Zorn, during the reading of his paper, explained that what he meant by Symbolic Rubber was in the sense of using a piece of indiarubber for the purpose of erazing pencil marks, or, to apply other words, the rubbing out of ideas and views that were unsound. In this sense he dealt with, among other subjects, the attempted creation of watertight compartments in industry, and the hoarding of "business secrets."

For some time past he had advocated the formation of a Rubber Parliament or a Central Council for the whole industry. This notion had been derided by certain people who wrote to the newspapers (generally, he noticed, under pseudonyms and not under their own names), and these critics had usually dubbed him an idealist; apparently under the impression that this settled the whole affair, but not one of them had as yet brought forward a single solid argument against the proposal.

One of the reasons that he valued the Institution of Rubber Industry so highly was that it provided in itself a sort of nucleus for this idea of a "Rubber Parliament." Let them consider for a moment what was the bearing of this upon the sort of questions with which they were faced in the rubber industry. He would run over a short list of matters which were occupying the attention of one section or another of the industry to-day, and would start with the question of the relative position of planter and manufacturer. They were well aware what conflicting views had been expressed regarding the subject of the restriction of output of raw rubber, and the Stevenson Committee's report upon this subject. Within the last fortnight, a resolution had been passed by the Indiarubber Manufacturers' Association, protesting against the idea of such restriction. For his own part, he regarded the restriction as a temporary expedient to meet a temporary departure form normal conditions, and from that point of view he was a supporter of restriction. Nevertheless, he welcomed the fact that the Indiarubber Manufacturers' Association had passed its resolution, because the only way to come to any agreement upon such questions was to know, in the fisrt instance, where they all stood. It was impossible to arrive at anything definite

with people who sat upon the fence and refused to come down on either one side or the other. He took it that the Indiarubber Manufacturers' Association was ready to bring forward arguments in support of the position which it had taken up. This could be compared with the arguments on the other side, and it was just the thrashing out of questions in this way which made it possible to clear up a problem. There was no necessity to allow any hostility to enter in. Some people seemed quite unable to picture anything except a never-ending fight between the planter and the manufacturer —alternations of "top dog" and "under dog." He thought that might be described as an unbusinesslike and unscientific view.

He understood that it was claimed by the American manufacturers that in respect of manufactured rubber they were able to supply goods which, in finish, and especially in colour, were far ahead of the rubber products of any other country. He would like to know whether there were good grounds for that claim, and if so, what was the explanation? Could the English manufacturer turn out coloured goods of as high a class as the American? If not, could any of their chemists tell them the reason? There was also the question of the relations between the manufacturer and the distributor—using the latter term to cover both the wholesale and retail sides. He understood that the distributor blamed the manufacturer for lack of enterprise and for not giving him what he wanted; the manufacturer, on the other hand, complained of many distributors' methods. A further point was one which had been rather forced upon his notice as Chairman of the Rubber Shareholders' Association. From letters which were constantly reaching him, he knew that the general public was under the impression that there was gross profiteering between the rubber tree and the shop counter. During the last 12 months he had found out that the rubber manufacturers had gone through a very bad time since the war: quite as bad a time in their way as the planters had endured. As far as he could ascertain, goods were leaving the factory at distinctly competitive prices. Yet when a member of the public quoted the retail price which he had had to pay for some manufactured rubber article, he could not pretend to suggest that the price was a reasonable one. Another question was that of labour difficulties.

The Rubber Growers' Association had been steadily at work in the matter of propaganda for some time, and a campaign of collective advertising for increasing the consumption of rubber goods was now on the point of being launched.

He had used for his parable the thought of rubber in one of its commonest everyday uses—its use as an erazer—and had tried to show that what mankind stood in need of to-day in every department of life was the "rubbing out," the elimination of old beliefs, old prejudices, old fears, and especially the elimination of generally accepted but unreal limitations, and to pave the way for a real co-ordination of effort for the general welfare of the trade.

[CONTRIBUTION FROM THE JOHN HARRISON LABORATORY OF CHEMISTRY, UNIVERSITY OF PENNSYLVANIA.]

THE SODIUM TUNGSTATES. I.

By EDGAR F. SMITH.

(From the "Journal of the American Chemical Society," September, 1922.)

(Concluded from page 236.)

Benzidine hydrochloride produced a white, heavy precipitate, not soluble in an excess of the precipitant or in boiling water.

Phenylhydrazine hydrochloride was without visible reaction.

Naphthylamine hydrochloride gave a flesh-coloured precipitate, insoluble even in boiling water. Hydrochloric acid slowly decomposed it.

Aniline hydrochloride gave no precipitation.

That the ratio observed in the sodium salt (4:10) might be further confirmed, the subjoined salts were analysed. They were made by adding an excess of the respective metallic chlorides to boiling aqueous solutions of the 4:10 sodium salt. They were washed thoroughly with boiling water.

Calcium Salt.—A white granular powder, which did not melt on heating to intense redness.

Calc. for $4CaO.10WO_3.25H_2O$: CaO, 7.48; WO_3, 77.38; H_2O, 15.14. Found: CaO, 7.55; WO_3, 77.20; H_2O, 15.14.

The *barium* and *strontium* salts were also white insoluble granular powders, giving results agreeing very closely with the requirements of the formulæ, $4BaO.10WO_3.22H_2O$ and $4SrO.10WO_3.26H_2O$.

The *nickel* salt is a greenish-white powder. The *cobalt* salt is pink in colour and very granular. Both are insoluble in hot water. Their analytical data conformed closely with the demands of the formulæ, $4NiO.10WO_3.34H_2O$, and $4CoO.10WO_3.35H_2O$.

The *manganese* salt, white in colour, resembled freshly precipitated calcium oxalate from a cold solution, and on standing became coarsely granular in character. The results from several analyses were concordant and pointed to the formula, $4MnO.10WO_3.30H_2O$.

Sodium paratungstate, $5Na_2O.12WO_3.28H_2O$.—On drying at 100° until its weight was constant this salt lost exactly 11 per cent. of its water content.[18] This percentage was equivalent to 21 molecules of water which, deducted from the total water content, 28 molecules, left 7 molecules as fixed water or water of constitution. In short, this amount of water was probably combined in the form of tungstic acid (H_2WO_4), and the formula of paratungstate might well be written, $(5Na_2O.5WO_3.7H_2O.7WO_3).21H_2O$. Such a formulation would indicate that the paratungstate was an acid salt.

Upon casting about among the various sodium tungstates for a possible coroboration of the light which was thrown upon the constitution of the para salt, it was discovered that sodium metatungstate $Na_2O.4WO_3 10H_2O$, when dried at 100° to constant weight, lost 11.7 per cent. of water,[19] corresponding to 7 molecules of water, which, deducted from the total water content (10 molecules), left 3 molecules as water of constitution, so that the meta salt might be expressed thus: $Na_2O.WO_3.3H_2O.3WO_3 7H_2O$.

The well defined barium metatungstate, $BaO.4WO_3.9H_2O$, similarly dried, lost 8.65 per cent. of water,[20] corresponding to 6 molecules, which therefore would justify the formula, $BaO.WO_3.3H_2O.3WO_3.6H_2O$.

Scheibler mentioned[21] that on exposing metatungstic acid to a red heat, its loss in weight was 15.85 per cent., equivalent to 9 molecules of water; but, that on heating the acid to 100° until its weight was constant, the loss was 11.5 per cent., corresponding to 6 molecules of water of crystallisation, which would point to the following formula, $H_2O.WO_3.3H_2O.3WO_3.6H_2O$.

Four portions of the 4:10- salt ($4Na_2O.10WO_3.23H_2O$) were strongly ignited and lost 13.80 per cent., 13.79 per cent., 13.81 per cent. and 13.73 per cent. of water respectively, corresponding to 23 molecules of water. Again, 4 samples of the salt were dried at 100° to constant weight, when the loss was 10.23 per cent., 10.27 per cent., 9.4 per cent., and 9.80 per cent. respectively, corresponding to 17 molecules (10.24 per cent.) of water of crystallisation, so that if this quantity be subtracted from 23 molecules, 6 molecules would remain as water of constitution and the formula of the salt might be written: $4Na_2O.4WO_3.6Na_2O.6WO_3.7H_2O$, which would stamp it as a very definite acid salt.

The evidence that not only the 4:10- salt but the other sodium salts to which attention has been called, were in reality acid salts suggested that their acidity might be determined.[22] This was done with a 0.1 N sodium carbonate solution, using methyl orange as an indicator. In every instance the acidity was the same as indicated in the preceding formulæ. Further, conductance experiments were made, using barium hydroxide to neutralise the acid present, when the break in the conductivity curve corresponded with the work set forth in the preceding experiments. A series of experiments was plotted for the 5:12- salt, the 4:10- salt, and the 1:4- salt, with most satisfactory results. hence there is no reason why the particular salt (4:10), under discussion in this communication, should not be formulated $4(Na_2O.WO_3).6(H_2O.WO_3).17H_2O$. It could also be graphically set forth after the manner of Werner,[23] which is possible, too, for the other salts but as these are still under study, being exposed among others to X-ray analysis, further comments on their constitution will be withheld for the present, and the antiquated formulæ[24] retained for comparison's sake, and their use will therefore be excused.

18. *Ref.* 4, *p.* 287.
19. *ibid.*, 4, *p.* 301.
20. *ibid.*, 4, *p.* 307.
21. *ibid.*, 4, *p.* 310.

22. *Schmidt, Am. Chem. J.*, 8, 16 (1886).

23. *Werner, J. prakt. Chem.*, [2] 77, 439 (1908); *Z. anorg. Chem.*, 69, 247, 261 (1910); 70, 73 (1911).

24. *Z. anorg. Chem.*, 70, 300 (1911).

SUMMARY.

Summarised, the preceding experiments demonstrate the following points:

1. The 4:10- salt represents a very definite series among sodium tungstates.

2. Forcher's procedure leads to the 4:10-salt and not to the 5:12- salt.

3. Formic acid, acting on normal sodium tungstate, produces only the 4:10- salt.

4. The 9:22- salt is a mixture of the 4:10- and 5:12- salts.

5. The 4:10- salt is an *acid* salt, as proved by the difference in its kind of water content, the ready neutralisation of its acidity, and by conductance experiments during its neutralisation.

6. The analysis of a series of new salts confirms in every way the ratio 4:10 between the basic and acid oxides.

The writer has been graciously assisted in his experimental work by Messrs. E. P. Fenimore and Russell Davis, as well as by his associate, Dr. H. S. Lukens, to whom he would here express his thanks, and also to the Trustees of the Carnegie Institution in Washington for the grant which has made possible this study and kindred studies now in progress.

Philadelphia, Pennsylvania.

GENERAL NOTES.

NON-FERROUS METALS.

A pamphlet, "Research Work in Progress," has just been issued by the British Non-Ferrous Metals Research Association, of 71, Temple Row, Birmingham. The investigations in hand cover many important problems of the Copper, Brass, Aluminium, Nickel and Lead industries, as well as subjects of importance to all users of such metals. The support given to this Association by the leading firms seems to be most encouraging, but the field covered is very wide, and many of these researches, such as those on the improvement of brass, on metal polishing, and on soldering, should attract the attention and support of many other sections of industry. The user is apt at first sight to overlook the fact that he is even more interested in the improvement of quality of his raw material than the manufacturer of the metal. In the case of failure, however, it is the user who always bears the greater loss, since he sacrifices all the time and workmanship which has been expended on the article being manufactured.

The Bureau of Information of the Association also seems to be doing excellent service in distributing to members reports of the results of the experimental researches, and acting as a live intelligence service collecting and distributing information likely to be of service to the industry from the far corners of the world.

Finally, some indication is given of the further work which the Council hope to take up when additional financial support is forthcoming, which includes problems of importance to the electrical industries, to Die Casters, and to the Tin Plate trade.

ETHYL ALCOHOL FROM LARCH.

The production of ethyl alcohol from Western Larch (*Larix occidentalis*) has been studied by E. C. Sherrard (*J. Ind. Eng. Chem.*, 1922, p. 948). The wood was extracted with water to obtain the galactan, which was then hdyrolysed to galactose by means of sulphuric acid. The acid solution was next neutralised with lime, and after removing the $CaSO_4$, fermented with a special culture of *Saccharomyces cereoisiæ*. The woody residue was also hydrolysed under pressure, and the liquid similarly neutralised and fermented. The sum total of alcohol formed corresponded to 10.25 per cent. resulting from 29.75 per cent. of total reducing sugars produced on hydrolysis. On hydrolysis of the original wood under pressure, an average of 29 per cent. reducing sugars were formed, this giving an actual yield of 10.65 per cent. of alcohol. For fermentation the temperature of the sugar solution must be kept at 85°-90° F., and the acidity must be carefully regulated.

THE ATTEMPTED DECOMPOSITION OF TUNGSTEN.

An acount is given in a recent number of the *Journal of the American Chemical Society** of some experiments carried out by Gerald L. Windt and Clarence E. Irion to obtain laboratory evidence of atomic decomposition at very high temperatures.

Tungsten was chosen for the experiment on account of its high atomic weight and very fine wires of this metal were exploded *in vacuo*, and in carbon dioxide by a current of electricity. Temperatures as high as 20,000° (Fah.?) are said to have been obtained.

In the vacuum experiments every care possible appears to have been taken to remove all gases previous to the explosion, and the whole research has been carried out in a most thorough manner, but the results cannot be regarded as conclusive.

After the explosion of wires *in vacuo*, spectroscopic examinations of the residual gas showed the lines of helium, but whether it really was the result of disintegration of the tungsten atom, or whether it was driven out from the electrodes by the exploding current was uncertain.

The experiments in carbon dioxide gave a residue gas that was not absorbed by potassium hydroxide solution, but the authors admit that much further research will be necessary, and regret that exaggerated accounts of the work have appeared in the Press.

* *Journal of the American Chemical Society*, Vol. XLIV., No. 9, Sept., 1922.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

The next meeting of the Society of Public Analysts and other Analytical Chemists will be held on Wednesday, November 1, at the Chemical Society's Rooms, Burlington House, Piccadilly, W., at 8 p.m.

The following papers will be read:—

"The Colorimetric Estimation of Pyrogallol, Gallotannin and Gallic Acid," by C. Ainsworth Mitchell, M.A., F.I.C.

"The Estimation of Narcotine and Papaverine in Opium," by H. E. Annett, D.Sc., F.I.C., and M. N. Bose, M.A.

"The Estimation of Morphine," by J. R. Nicholls, B.Sc., F.I.C.

"Further Notes on the Estimation of Potassium; by Perchlorate and Cobaltinitrite Methods," by R. L. Morris, F.I.C.

INFORMAL DINNER.—Arrangements have been made for members and their friends to dine together at St. James' Restaurant, 178, Piccadilly (opposite Burlington House) at 6.30 p.m.

THE OPTICAL SOCIETY.

At a meeting of the Optical Society, held at the Imperial College, on Thursday, 12th October, 1922, Professor F. J. Cheshire, Vice-President, in the chair, the following papers were read and discussed:—

A Physical Study of Coma, by L. C. MARTIN, D.Sc.

A specially designed microscope objective and mounting, calculated to exhibit coma in the absence of spherical aberration and astigmatism, are described. Photographs of a star image, taken when the amount of coma is equivalent to that for which the light distribution has been calculated by the author, are found to verify the numerical work. The photometric examination of the photographic image is carried out by a special method.

Comparison of the Structure of Sand-blasted and Ground Glass Surfaces, by F. W. PRESTON, B.Sc.

Glass surfaces smoothed or "greyed" by loose abrasives in the usual way are compared with those produced by sand-blasting. The surfaces are so similar when produced by the two methods that they are practically indistinguishable, either by the naked eye or the microscope, and the development of the structure by etching shows that the resemblance is not merely superficial, but that the structure is in fact virtually identical. Thus, it appears that mere pounding of a glass plate can, and does, produce a surface which is structurally indistinguishable from a smoothed surface of a technical order.

Messrs. Adam Hilger, Ltd., exhibited a new type of chemical spectrometer, a new model of the Bunsen-Kirchhoff spectrometer for flame spectra, a student's model of the wave-length spectrometer (constant deviation type), and an interference accessory for testing microscope stands and fine adjustments.

LITERARY INTELLIGENCE.

Atomic Form, with special reference to the Configuration of the Carbon Atom, is the title of a volume written by Edward E. Price, and which will be published almost immediately by Messrs. Longmans, Green & Co.

At the present time the constitution of the Atom is the subject of physical theories which are widely separated from the author's ideas, and many persons may be disposed to consider them as inconsistent with the latest advances of scientific thought. Mr. Price asks for a more impartial consideration of this subject; so much has yet to be discovered, so many problems have yet to be elucidated, that no theory should be rejected which helps in any way the consideration of these problems.

NOTICES OF BOOKS.

The Microscope, by CONRAD BECK. Pp. 144. London: R. & J. Beck, Ltd., 68, Cornhill, E.C. 1921. 2s. 6d.

In this book Mr. Beck describes, in an interesting way, the structure of the microscope, its accessories and their uses. The construction and the optical principles involved are described very simply, but accurately and adequately. The important matter of correct illumination for various purposes is emphasised, and the correct methods of mounting and holding specimens are also described so that the beginner may obtain most suitable conditions for studying different objects. This section will appeal also to more experienced microscopists, who will obtain useful pieces of information by a perusal of this volume.

The various types of instruments are described, and there is a useful concluding chapter which indicates the possibilities of the recreation uses of the microscope.

In addition to a complete index, there is a nappendix giving the prices of such instruments, apparatus and accessories, which adds to the utility of this cheap little volume.

Many will find it a valuable companion for use with the microscope either at work or pleasure. J.G.F.D.

BOOKS RECEIVED.

The Manufacture of Dyes, by JOHN CANNELL CAIN, D.Sc. Pp. IX. + 274. 1922. Messrs. Macmillan & Co., Ltd., St. Martin Street, W. 12s. 6d.

New Patents.

THIS list is specially compiled for the *Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

26116—Akt Ges fur Anilin-Fabrikation.—Manufacture of tetrakisazo dye-stuffs. Sept. 27.

26117—Blew, E. G.—Extracting and segregating soft penetrable substances from an agglomeration of such substances and hard or impenetrable substances. Sept. 27.

26206—Brewer G.—Process for electrolytic separation of pure chromium in thick layers. Sept. 28.

26114—Lewis, G. P.—Molecular conversion of hydrocarbons and separation of resultant products. Sept. 27.

26022—Masters, C. L.—Process for separation of isameric naphthylamine sulpho acids. Sept. 27.

26000—Nitrogen Corporation—Synthesizing ammonia. Sept. 26.

Specifications Published this Week.

25232—Chemische Fabrik Griescheim-Elektron.—Manufacture of mono-azo dye-stuffs. Sept. 18.

25221—Howard, H.—Purification of hydrofluoric acid. Sept. 18.

164002—Farbwerke vorm, Meister Lucius & Bruning.—Manufacture of methylsulphites of secondary aromatic-aliphatic amines.

166896—Collard, C.—Extraction of gelatine.

185612—British Dyestuffs Corporation.—Manufacture of new triarylmethane colouring matters.

183428—Farbwerke vorm. Meister Lucius & Bruning.—Manufacture of sulphonic acids of the 2:3-oxynaphthoic acid arylides.

185779—Plausons Parent Co.—Process for the manufacture of oily pastes or emulsions from mineral and other oils.

185842—Pearson, E. R.—Electrolytic treatment of metalliferous materials containing tungsten or molybdenum.

185913—Imray, O. Y.—Manufacture of amino-alcohols of the quinoline series.

167769—Riedel, A.—Treatment of ammonium chloride.

Abstract Published this Week.

Sodium Potassium Ammonium Phosphates.—Patent No. 184206.—A patent has been granted for improvements in the preparation of Sodium Potassium, Ammonium Phosphates, invented by Mr. J. G. Williams, of 2, Melbourne Road, West Bridgford, Nottinghamshire.

Mineral or precipitated calcium phosphate or bone ash is mixed with a solution of sodium potassium, or ammonium sulphate, and the product treated with sulphur dioxide. The reaction products are calcium sulphate and a soluble phosphate corresponding to the sulphate used, a soluble sulphite being also formed when tricalcium phosphate is treated. The formation of sulphite can be avoided if one of the three molecules of sulphate required for the reaction is replaced by one of sulphuric acid, and this may be accomplished, in the case of sodium phosphate, by the use of nitre cake. No sulphite is formed when precipitated calcium hydrogen phosphate is treated, and in this case the sulphur dioxide can be recovered by heating the filtered reaction liquid. Other acids readily volatile from hot solutions, such as acetic or formic acid, or carbon dioxide, or hydrogen sulphide, may replace sulphur dioxide.

Messrs. Rayner & Co. will obtain printed copies of the published specifications, and forward on post free for the official price of 1s. each.

THE CHEMICAL NEWS,

VOL. CXXV., No. 3264

MINERALS DEPOSITED BY BACTERIA IN MINE WATER.

Observations in the Kimberley Diamond Mines.

(*Continued from Page* 243.)

After Mr. Drew's results, there appears now nothing anomalous in inferring the assistance of bacteria in producing such deposits as ours, and I am tempted to infer that it is the persistent activity of such organisms—be their origin what it may—over this long period of time that has been largely operative in producing them.

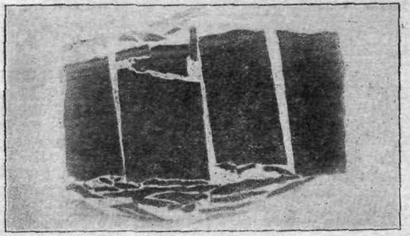
I do not claim that we have secured the actual Bacillus Calcis of Mr. Drew, but we do at any rate appear to have met with an organism possessing somewhat similar functions.

Further interesting features were observed, when some of the pipe deposit was finely powdered and examined under the microscope. Innumerable parallel striations were visible on nearly every particle: the spaces between them measuring from 1/600 to 1/2,000 of an inch (*Fig.* 4). By carefully adjusting the focus, the fractured ends of many of these particles presented a series of little steps, revealing their structure as composed of extremely thin layers of these thin layers was quite homogeneous superimposed one upon another, and each and almost transparent.

A thin portion of the deposit from one of the stones was cut off at right angles to the surface, and ground down to a tenuity suitable for microscopical inspection. (*Fig.* 5). Owing to the brittle nature of the material, the preparation of this slide was a very tedious operation, and required the most delicate and patient handling. Even now the photo is not so good as one could wish, and only a tiny portion of the mounted specimen was sufficiently thin to allow a photograph being taken through the microscope (*Fig.* 6). This affords some idea of the very great number of layers that has gone to build up this mass.

The only feasible explanation that I can offer for the deposition of these extremely fine layers one upon the other, is that it is the work of these same micro-organisms. When first observed in our bottle of water, they had produced on the glass an extensive transparent adhesive film of matter. This water was collected as it dripped from the roof. The stones were coated by the same process of dripping. Each drop falling on the more or less flat surface of a stone tends to flow all over it, thus at the same time evenly distributing its micro-

(Fig. 4.)



(*Fig.* 5.)

inhabitants. As a result of the intense activity of such myriads of organisms, it is not long before a strongly adherent, thin confluent film of calcareous matter is produced. By the time another drop falls on the same spot, a bed or layer of the earlier drop is established, and the second drop then proceeds to repeat the process, and thus layers are produced continuously, though slowly, one upon another, with every succeeding drop that falls on the stone. It is to be noted, in view of the rather considerable area of the roof over which the water trickles, that the fall of drops seems fairly rapid; but the dropping is very uneven, so that a drop seldom falls from the same place except at long intervals. It is not surprising, therefore, that a great deal of time is required to produce even $\frac{1}{4}$ of an inch of these deposits on any one article.

There are, of course, alternative natural processes which suggest themselves as probable causes of such deposits. Stalactitic formations sometimes show very thin concentric layers; but these are undoubtedly produced by a process of evaporation and from fairly strong solutions of Bicarbonate of Lime; but such evaporation seems to be ruled out in the case of our samples. Moreover, none of these deposits ever assume stalactitic form.

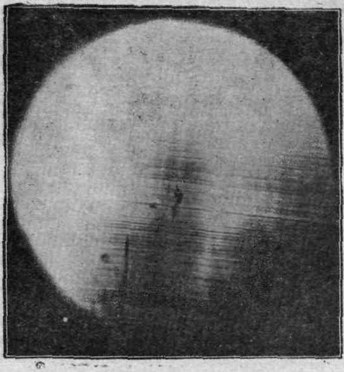
Travertine, too, and other native forms of Calcium Carbonate, are assumed to form from the action of certain algæ, which, by absorbing the semi-combined CO_2, in the absence of free CO_2, causes $CaCO_3$ to fall out of solution. This cause is not excluded here, though, so far, no evidence has turned up in support of it. Again, too, the algæ do not absorb the Calcium Carbonate into their structure, while the organisms found on the sides of our bottle can be easily shown to consist largely of the Calcium Carbonate.

However, further bacteriological work is being carried out in connection with this matter.

There is still another problem presented by these anomalous deposits which requires elucidation, viz., the colour of the mass and the brilliantly black surfaces. What is this colouring matter and whence derived?

When fragments of the pipe core were shown to individuals curious enough to speculate as to their nature, they usually declared, without hesitation, that it was a specimen of crocidolite (cat's eye stone). After only a superficial microscopical inspection, this is not an entirely unreasonable suggestion, as the polished pieces of it do strikingly simulate that native mineral. Its fibrous structure and colour are, however, the only features it possesses in common with crocidolite. Its brittleness and chemical composition sufficiently indicate that it cannot be this substance.

Another suggestion, offered by some who were acquainted with its source, was that it was derived from the insulating material of old electric cables lying in the mine. This was quite feasible and operations were conducted to decide this point. The substances that would be removed from such material by a soda alkaline water (such as this water is) are resin and shellac. There are excellent chemical tests for identifying these two bodies, but after separating the organic matter from the calcium carbonate by a special method and submitting it to these particular tests, the answer, as a



(Fig. 6.)

Cabinet Minister would say, was in the negative.

The electric cable origin may therefore be eliminated from further consideration.

A third suggestion was that it was the fossilised trunk of a tree. When a long piece of the pipe core is inspected, it does rather resemble a tree stem with the central portion removed. But of course fossiilsed trees do not grow in modern 6 inch iron pipes in diamond mines.

After inspecting these various deposits *in situ*, two probable sources of this colouring matter seemed pretty obvious: it may have been derived from rotten timbes; or from soluble portions of animal excreta, or from both. Both occur in the mine, and in contact with a water containing so active an alkali as carbonate of soda, some of them would be carried into solution.

The fact, that practically all these coloured deposits occur in the *immediate* vicinity of the shaft, where there is always much timber, and trickling alkaline water, at once suggested a ligneous origin for this colour.

A great deal of work was performed to prove this point, though less would have sufficed had it not been for the other obvious alternative. The evidence for the influence of exerementitious matter was slight and therefore inconclusive; the presence of small quantities of ammoniacal compounds and traces of phosphate of lime being the only indications. Moreover, these were not present in all the samples that were operated on. Attention was therefore mainly devoted to confirming the woody origin.

There are a great number of definite and *indefinite chemical* bodies existing in wood: some exceedingly complex; and to isolate and identify them all would occupy far more time than can be spared in a busy laboratory, and it would, besides, be quite unnecessary.

Cellulose is a substance that is derived entirely from vegetable matter. It is a product of the so-called metabolism of living plant tissues, so that, if we meet with a substance in an alkaline water, which after isolation, responds to the generic tests for celluloses, we may reasonably conclude that that water has been in contact with woody matter in some stage of its travels; and if, further, we can isolate the same kind of substance from the actual deposit, which we know to be derived from the water, the inference is again perfectly logical that some, at any rate, of this organic matter has been acquired from the same source.

Not to unduly enlarge this report, I may state as a result of many carefully con-

ducted experiments and tests, I was able to isolate from both the water and deposits, an organic substance which exhibited all the characteristics of a cellulose material.

This result was further confirmed in another way. Some of the decayed timber, which was brought from the mine, was digested with water containing carbonate of soda (N/20), thus imitating as far as we could the conditions we imagined to have occurred in the mine. When the organic matter derived from the timber by this means was isolated from the water and tested, precisely the same results were obtained for cellulose material as in the original samples.

We may now, therefore, state unequivocally that the unusual colour of all these deposits is derived from decaying timber after contact with an alkaline water.

As a final proof that these alkaline waters do come in contact with timber, the slight muddy deposit that was obtained from one of the samples of alkaline water that was collected as it trickled down the walls of the shaft, was examined by means of the microscope. Every portion inspected revealed the presence of many tiny particles of organised structure, such as "cells with bordered pits" and fragments of medullary rays so characteristic of Coniferous or Pine wood, and of Pine wood only, as used in the shaft timbering.

At the close of the lecture, Dr. Fred E. Wright, of the Carnegie Institution of Washington, U.S.A., contributed some remarks and indicated the wide interest and importance of the observations made by Mr. Parry.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

(SECTION A.—MATHEMATICS AND PHYSICS.)

THE THEORY OF NUMBERS.

ADDRESS BY PROFESSOR G. H. HARDY, M.A., F.R.S., PRESIDENT OF THE SECTION.

(*Continued from Page* 247.)

It seems to me, then, that we must regard Mersenne's assertion as exploded; and for my part it interests me no longer. If he is wrong about 89 and 107, I do not care greatly whether he is wrong about 137 as well or not, and I should regard the computations necessary to decide as very largely wasted. There are so many much more profitable calculations which a computer could undertake.

I hope that you will not infer that I regard the problem of perfect numbers as uninteresting in itself; that would be very far from the truth. There are at least two intensely interesting problems. The first is the old problem, which so many mathematicians have failed to solve, whether a perfect number can be odd. The second is whether the number of perfect numbers is infinite or not. If we assume that all perfect numbers are infinite, we can state this problem in a still more arresting form. *Are there infinitely many primes of the form* $2^n - 1$? I find it hard to imagine a problem more fascinating or more terribly difficult than that. It is plain, though, that this is a question which computation can never decide, and it is very unlikely that it can ever give us any data of serious value. And the problem itself really belongs to a different chapter of the theory, to which I should like next to direct your attention.

4. *Are there infinitely many primes of the form* $n^2 + 1$? Let me first remind you of some well-known facts in regard to the distribution of primes.

There are infinitely many primes; their density decreases as the numbers increase, and tends to zero when the numbers tend to infinity. More accurately, the number of primes less than x is, to a first approximation,

$$\frac{x}{\log x}$$

The chance that a large number n, selected at random, should be prime is, we may say, about $\frac{1}{\log n}$ Still more precisely, the "logarithm-intergral"

$$\text{Li } x = \int_2^x \frac{dt}{\log t}$$

gives a very good approximation to the number of primes. This number differs from Li x by a function of x which oscillates continually, as Mr. Littlewood, in defiance of all empirical evidence to the contrary, has shown, between positive and negative values, and is sometimes large, of the order of magnitude $\sqrt{x}$ or thereabouts, but always small in comparison with the logarithm-integral itself.

Except for one lacuna, which I must pass over in silence now, this problem of the general distribution of primes, the first and central problem of the theory, is in all essentials solved. But a variety of most exciting problems remain as to the distribution of primes among numbers of special forms. The first and simplest of these is

that of the arithmetical progressions: *How are the primes distributed among all possible arithmetical progressiosn $an+b$?* We may leave out of account the case in which a and b have a common factor; this case is trivial, since $an+b$ is then obviously not prime.

The first step towards a solution was made by Dirichlet, who proved for the first time, in 1837, that any such arithmetical progression contains an infinity of primes. It has since been shown that the primes are, to a first approximation at any rate, distributed evenly among all the arithmetical progressions. When we pursue the analysis futrher differences appear; there are on the average, for example, more primes $4n+3$ than primes $4n+1$, though it is not true, as the evidence of statistics has led some mathematicians to conclude too hastily, that there is always an excess to whatever point the enumeration is carried.

The problem of the arithmetical progressions, then, may also be regarded as solved; and the same is true of the problem of the primes of a given quadratic form, say $am^2+2bmn+cn^2$, homogeneous in the two variables m and n. To take, for instance, the simplest and most striking case, there is the natural and obvious number of primes m^2+n^2. A prime is of this form, as I have mentioned already, if and only if it is of the form $4k+1$. The quadratic problem reduces here to a particular case of the problem of the arithmetical progression.

When we pass to cubic forms, or forms of higher degree, we come to the region of the unknown. This, however, is not the field of inquiry which I wish now to commend to your attention. The quadratic forms of which I have spoken are forms in two independent variables m and n; the form n^2+1 of my question is a non-homogeneous form in a single variable n, the simplest case of the general form $an^2+2bn+c$. It is clear that one may ask the same question for forms of any degree: Are there, for example, infinitely many primes n^2+2 or n $+1$? I do not choose n^3+1, naturally, because of the obvious factor $n+1$.

This problem is one in which computation can still play an important part. You will remember that I stated the same problem for perfect numbers. There a computer is helpless. For the numbers 2^n-1, which dominate the theory, increase with quite unmanageable rapidity, and the data collected by the computers appear, so far as one can judge, to be almost devoid of value. Here the data are ample, and, though the question is still unanswered, there is really strong statistical evidence for supposing a particular answer to be true. It seems that the answer is affirmative, and that there is a definite approximate formula for the number of primes in question. This formula is

$$\tfrac{1}{2}\mathrm{Li}\sqrt{x}\times(1+\tfrac{1}{3})(1-\tfrac{1}{5})(1+\tfrac{1}{7})(1+\tfrac{1}{11})\ldots,$$

where the product extends over all primes p, and the positive sign is chosen when p is of the form $4n+3$. Dr. A. E. Western has submitted this formula to a most exhaustive numerical check. It so happens that Colonel Cunningham some years ago computed a table of primes n^2+1 up to the value of 15,000 of n, a limit altogether beyond the range of the standard factor tables, and Cunningham's table has made practicable an unusually comprehensive test. The actual number of primes is 1,199, while the number predicted is 1,219. The error, less than 1 in 50, is much less than one could reasonably expect. The formula stands its test triumphantly, but I should be deluding you if I pretended to see any immediate prospect of an accurate proof.

5. The last problem I shall state to you is this: *Are there infinitely many prime-pairs p, $p+2$?* One may put the problem more generally: *Does any group of primes, with assigned and possible differences, recur indefinitely, and what is the law of its recurrence?*

I must first explain what I mean by a "possible" group of primes. It is possible that p and $p+2$ should both be prime, like 3, 5, or 101, 103. It is not possible (unless p is 3) that p, $p+2$ and $p+4$ should all be prime, for one of them must be a multiple of 3: but p, $p+2$, $p+6$ or p, $p+4$, $p+6$ are possible triplets of primes. Similarly

$$p,\ p+2,\ p+6,\ p+8,\ p+12$$

can all be prime, so far as any elementary test of divisibility shows, and in fact 5, 7, 11, 13 and 17 satisfy the conditions. It is easy to define precisely what we understand by a "possible" group. We mean a group whose differences, like 0, 2, 6, have at least one missing residue to every possible modulus. The "impossible" group 0, 2, 4 does not satisfy the condition, for the remainders after division by 3 are 0, 2, 1, a complete set of residues to modulus 3.

There is no difficulty in specifying possible groups of any length we please.

We define in this manner, then, a "possible" group of primes, and we put the questions: Do all possible groups of primes actually occur, do they recur indefinitely often, and how often on the average do they recur? And here again it would seem that the answers are affirmative, that all possible groups occur, and continue to occur for ever, and with a frequency whose law can be assigned. The order of magnitude of the number of prime-pairs, p, $p+2$, or p, $p+4$, or p, $p+6$, both of whose members are less than a large number x, is, it appears,

$$\frac{x}{(\log x)}$$

The order of magnitude of the corresponding number of triplets, of any possible type, is

$$\frac{x}{(\log x)^3}$$

and so on generally. Further, we can assign the relative frequencies of pairs or triplets of different types; there are, for example, about twice as many pairs whose difference is 6 as pairs whose difference is 2. All these results have been tested by actual enumeration from the factor tables of the first million numbers; and a physicist would probably regard them as proved, though we, of course, know very well that they are not.

There is a great deal of mathematics the purport of which is quite impossible for any amateur to grasp, and which, however beautiful and important it may be, must always remain the possession of a narrow circle of experts. It is the peculiarity of the theory of numbers that much of it could be published broadcast, and would win new readers for the *Daily Mail*. The positive integers do not lie, like the logical foundations of mathematics, in the hardly visible distance, nor in the uncomfortably tangled foreground, like the immediate data of the physical world, but at a decent middle distance, where the outlines are clear and yet some element of mystery remains. There is no one so blind that he does not see them, and no one so sharp-sighted that his vision does not fail; they stand there a continual and inevitable challenge to the curiosity of every healthy mind. I have merely directed your attention for a moment to a few of the immediately conspicuous features of the landscape, in the hope that I might sharpen your curiosity a little, and that some of you perhaps might feel tempted to walk a little nearer and take a rather closer view.

VITAMINS—ACCESSORY FOOD FACTORS.

What Are They?

Dr. F. W. Alexander, Medical Officer of Health for the Borough of Poplar, has issued a Special Report on the above subject, and this has been ordered to be printed by the Maternity and Child Welfare Committee.

The following extracts are taken from this valuable report.

PART I.

"Recent research has shown that the requirements of the human organism as regards diet cannot be met entirely by an adequate supply of protein fat, carbo-hydrate, inorganic salts and water. It has therefore modified the common belief of ten or more years ago, when the attention of physiologists was focussed upon the Calorie, or energy value of the diet. It is now established that, in addition to these necessary constituents, certain unidentified principles known as accessory food factors or "vitamines," must also be present in order to maintain health and prevent the occurrence of "deficiency diseases." These substances have not so far been isolated, little is known of their chemical or physical properties, and at the present time their presence can only be detected by experiments with animals."—(Extract from Memorandum issued by the British Committee on Accessory Food Factors, June, 1919.)

Vitamins are constituents of food, the chemical structure of which is not yet known, which in very minute quantities exert a far-reaching influence over the body. They exist in only very minute quantities.

Vitamins are not a medicine, but a necessary constituent of food, and are required by all forms of animal life, birds, animals, children and men. Plants require Vitamins called Auximones.

Some liken Vitamins to enzymes as being in the nature of Catalysts.

Vitamins evidently exert an influence quite out of proportion to the quantity that is present. It has been suggested that they are not exactly food, but "produce a

harmonious interaction between materials *in the food and their host.*" They are catalysts or hormones or accessory factors.

The Vitamins appear to be concerned intimately in nutrition, and for this reason may be called accessory growth substances. Their absence from the dietaries is associated with the production of what have been termed deficiency diseases, such as rickets in children, scurvy, beri-beri, polyneuritis, and a certain sloughing and ulceration of the cornea of the eye in advanced conditions of starvation or malnutrition.

It has been stated that disease in many, if not in most, cases is due to the lack of proper defensive elements (Vitamins) in the body rather than to the presence of an invading germ.

Animals must get all their food from plants, for the animal body cannot produce within itself the substances needed to support life. Where one animal preys upon another it is simply taking from the other animal what that animal has previously collected from the plant world.

PART II.

Kinds of Vitamins or Accessory Food Factors.

The word "Vitamine" was coined by Casimir Funk, a Pole. The first part of the word indicates its relation to the life process (Vita—life); the second to its chemical nature (Amine—a substance which may be derived from ammonia, etc.). The word Vitamine has crept into general use and is now spelled "Vitamin," the terminal "e" having been dropped as it implied that the substances had known chemical constitution, which is at present not justified.

The accessory food factors at present recognised are three in number:—

(1) Fat—soluble "A" growth factor or antirachitic factor called "Vitamin A."

(2) Antineuritic or antiberi-beri factor identified with the water-soluble "B" growth factor of the American investigators, called "Vitamin B."

(3) Water-soluble antiscorbutic Vitamin, called "Vitamin C."

It is thought there may be a fourth Vitamin, a fat-soluble "D."

When more Vitamins are taken into the body than are needed, the excess is simply burned as an excess of proteins, for other uses in the body; consequently, they are harmless.

The body is able to store a reserve of Vitamin A. A portion of Vitamin B is needed for the digestive processes. Children during growth period are more immediately dependent upon Vitamins than adults, and suffer most under famine or war conditions when the food supply is curtailed.

The A Vitamin is a constituent of all cells and is necessary for the promotion of growth in the young as well as for the maintenance of health in adults. Animals can be cured of rickets by adding to their diet antirachitic (fat-soluble A) Vitamins, *e.g.*, butter fat, cod-liver oil or extracts of green vegetables. Vitamin A is present in animal oils and fats except lard, and absent in vegetable oils and fats.

The fat-soluble A Vitamin is the only one which seems to have some reserve store in the body. If it is absent from their food young animals will continue to grow for a short time, and nursing mothers will continue supplying it to their infants.

It is stated that liability to tuberculosis is greatly increased by the absence of Vitamin A.

The Hoover Commission found that wherever people lacked butter and milk containing Vitamin A, tuberculosis became prevalent.

The absence of Vitamin A from food gives rise to an eye disease called Xerophthalmia or Keratomalacia, and to a greatly lowered state of health.

Vitamin B is a constituent of all cells, and is necessary for the maintenance of growth; its absence from the wood is an essential cause of Beri-beri.

"The chief source of B-Vitamin in our food is the seeds of cereals and other plants, but the factor is removed from cereal seeds in the process of milling. Sugar, sago, and other farinaceous products are lacking in B-factor, meat and fish are poor, offal and eggs in comparison rich. Vegetables and milk contain small amounts. The quantity in these foodstuffs is scarcely sufficient to balance the large carbo-hydrate consumption of white flour in our diet, unless eggs, fruits and vegetables are eaten in great quantities. The products richest in B-Vitamin are the germs of cereals and yeast. Germ as such is not consumed by humans (except in wholemeal bread), and the yeast used in baking bread is not sufficient. Yeast contains B-Vitamin in great concentration, and palatable preparations made therefrom

can compensate for the lack of B-Vitamin in other foods. No ill effects have been ascribed to too great a consumption of foods rich in B-Vitamin, and it is likely that certain cases of vague ill-health would be improved by the consumption of additional quantities of B-Vitamin."—*Lancet*, 10th Dec., 1921. Page 1,228.

Vitamin B is widely distributed throughout natural foodstuffs. Its richest sources are the germs of seeds, eggs, yeast, wheat and rice, bran, peas, beans, lentils and cellular organs (such as liver, brain, sweetberads, fish-roe, kidney and hard muscle). Nuts are comparatively rich in it; cows' milk is less so. Meat (beeg and muton) contain it in *comparatively* small amounts, and the flesh of fish is poor in it. Vegetables and fruit contain it in larger amounts than was formerly supposed. It is also richly abundant in yeast and yeast extracts, *e.g.*, yeast extract and autolysed.

THE THERM.

Report of the Fuel Research Board on Gas Standards.*

Preface.

In re-issuing the reports of the Fuel Research Board on Gas Standards, the Department of Scientific and Industrial Research desire to assist the general public to understand the importance of this subject from the points of view of the producers and consumers of gas, and its bearing on the conservation of the national coal resources.

Twenty-five years ago the gas used by householders for lighting purposes was, in the main, burnt directly in the old-fashioned burner. The value of the gas as supplied to the householder then depended on its illuminating quality when so burnt. With the introduction of the incandescent mantle, these conditions were entirely changed. In the incandescent burner the gas is mixed with air and burns with a bluish flame. Its value for lighting purposes depends on the heat of this flame, which is used to make the mantle white hot. As a result, the value of the gas for lighting purposes supplied to the householder to-day depends on its heating quality and not on its illuminating quality when burnt by itself. Simultaneously with this change, the improvement in the ordinary gas fire led to an increasing use of gas in the house in place of coal. In the gas fire, as in the incandescent burner, the gas is mixed with air and burns with a bluish flame. Its value depends on the heat which it supplies to the asbestos and fire-brick of which the gas fire is composed.

During the war the extraction of valuable products for the manufacture of explosives, the scarcity of coal and its poor quality led to a marked fall in the heating quality of the gas supplied to the consumer. The gas supplied was a mixture which contained a high proportion of nitrogen and other incombustible constituents. These incombustible constituents, technically called "inerts," merely diluted the gas, and were of no value to the householder for heating purposes.

The problem to be faced by the gas-supplying industry and the country after the war was therefore to answer the question—How can the gas regulations be amended so as to enable the Gas Undertakings to make the most economical use of our coal in the supply of gas to the public, and at the same time, how can it be ensured that the consumer shall pay for his gas at a price depending solely on its heating qualities? This was the problem which was referred to the Fuel Research Board by the Board of Trade.

The Fuel Research Board reached the conclusion that in the interests of the economy of our fuel resources, the Gas Undertakings ought to be allowed more liberty in determining the composition of the gas they supplied, since local conditions varied in different parts of the country ,and since there was varying local demand for the different by-products which could be obtained by different methods of manufacture. They also found the existing checks on the heating quality of the gas supplied through the mains to be inadequate, and the tests required by the then existing Acts to be insufficient to secure that the undertakings supplied gas of a uniform and stated *heating* quality. Further, it was clear that the interest of the consumer, while it required the encouragement of the most economical methods of producing gas, could only be secured if he were charged for the heat which the gas supplied to him would provide when burnt in *properly adjusted appliances*.

The solution recommended by the Fuel Research Board took account of all these considerations. The Gas Undertakings were to be required to declare the calorific or heating value of the gas they intended to

supply, and to keep to this quality within reasonable limits. The quality was to be recorded continuously by a recording calorimeter, and the records to be made available for inspection by the consumer. This method was to supersede the periodic test by the local gas examiners, of which notice was usually given to the Gas Undertakings. *At the same time whenever the Gas Undertakings altered the heating value of the gas they supplied they were to adjust, free of charge, the burners fitted in the households of their consumers.*

Secondly, the Board recommended a method by which the charge to the consumer should be based solely on the heating quality of the gas. If a Gas Undertaking supplied a gas of low heating quality, they would only be able to charge for the number of therms in each thousand cubic feet.

Thirdly, after the interests of the consumer had been protected in these two ways, the Gas Undertakings were to be given greater freedom in settling the composition of the gas they would supply, thus allowing greater variation in the methods of manufacture.

This reasonable liberty would tend to secure a minimum price of gas to the consumer and help to conserve the national coal resources.

As the result of a series of conferences, these principles received the general support of representatives both of the gas-making industry and of the consumers, and a scheme based upon the recommendations of the Board found legislative sanction in the Gas Regulation Act of 1920.

Department of Scientific and Industrial Research,
16, Old Queen St., Westminster,
London, S.W.1.

October, 1922.

* Copies of the Review are obtainable from H.M. Stationery Office, Imperial House, Kingsway, W.C., or through any Bookseller; post free 4d.

THE PREPARATION & PROPERTIES OF ORGANIC STANNO- AND STANNI-CHLORIDES.

PART V.—THE SALTS OF CERTAIN SPECIAL BASES.

By J. G. F. Druce, M.Sc., A.I.C.

In continuation of previous work (compare *The Chemical News*, 1919, CXVII, 1 and 87, ibid., CXIX, 73, ibid., 1922, CXXIV., 310), the stannichlorides of hydroxylamine, 5-amino-quinoline, 6 amino-quinaldine, and isoquinoline have been made. The stannochlorides of 5-amino-quinoline and 5-amino-quinaldine have also been prepared.

There has been considerable discussion regarding the constitution of hydroxylamine. This base is now generally recognised to exist in the tautomeric forms:—

I.		II.
NH_2OH	and	NH_3O.

Haber (*Ber.*, 1896, XXIX, 2444) has suggested that the hydroxyl structure I., accurately represents the substance in its salts. This was disputed by Ebler and Schott (*J. prakt. Chem.*, 1908, [2], LXXVIII., 289), but recently A. Michael (*Journ. Amer. Chem. Soc.*, 9121, XLIII., 315) has re-investigated this problem, and concludes that all the properties of the substance point towards its formula being NH_2OH. The existence of the stannichloride supports the view that in salts, at least, this formula accurately represents its structure.

It was thought that the salts of amino-quinoline and amino-quinaldine might be of interest since these bases are simultaneously primary and tertiary bases. Their salts have, however, shown no special characteristics.

The quinoline used in the preparation of the 5-nitro-quinoline which was used for making the 5-amino-quinoline double haloids, was prepared by the modification of Skraup's synthesis described by E. de Barry Barnett (*The Chemical News*, 1920, CXXI., 205). His method was found to be even more convenient than the modification previously described (Druce, *The Chemical News*, 1919, CXIX., 271).

The 6-nitro-quinaldine required in the preparation of the 6-amino-quinaldine salts was obtained by following the method described by Hamer (ourn. *Chem. Soc.*, 1921, CXIX., 1435) i a paper entitled "*A Comparison of som Isomeric iso-Cyanines.*"

EXPERIMENTAL.

Hydroxylamine Stannichloride

$(NH_2OH)_2.H_2SnCl$

Hydroxylamine hydrochloride (2 grams) and 5.3 grams of crystalline stannic chloride, $SnCl_4.5H_2O$, were dissolved together in 50 cc. of dilute hydrochloric acid. The concentrated solution gave a white micro-crystalline deposit on standing. This was filtered off, drained, and dried on a porous tile.

The stannichloride dissolved readily in cold water and the solution required heating before hydrolysis became apparent by the separation of a flocculent gelatinous precipitate. Sodium hydrate solution did not evolve ammonia gas from the solution.

Except hot alcohol, organic solvents did not dissolve hydroxylamine stannichloride. It did not melt on heating up to 300°, but appeared to undergo a shrinkage at about 270°.

On analysis: —

0.8695 grm. gave 0.3448 grm. SnO_2;
Sn = 30.3 per cent.
0.3330 grm. gave 0.7220 grm. AgCl;
Cl = 53.6 per cent.
$(NH_2OH)_2$. H_2SnCl_6 requires Sn = 29.73 and Cl = 53.25 per cent.

5-Amino-quinoline Stannochloride

$NH_2 \cdot C\ \ H_6$ N. H_2SnCl_4.

This salt has been obtained by warming 4 grams of 5-nitro-quinoline with 10 grams of tin and 100 cc. of concentrated hydrochloric acid. The yellow colour due to the nitro-compound disappeared, and on cooling, cyrstals separated. These were filtered off, re-dissolved in hot dilute hydrochloric acid, filtered, and the solution allowed to crystallise. The clusters of very pale yellow prisms which separated were filtered off, drained and dried on a porous tile in a desiccator over calcium chloride.

The stannochloride melted at 160° to a clear yellow liquid. It did not dissolve in water to a clear solution, and the cloudiness increased on warming.

On analysis:—

0.5983 grm. gave 0.2293 grm. SnO_2;
Sn = 30.2 per cent.
0.2339 grm. gave 0.3322 grm. AgCl;
Cl. = 35.1 per cent.
$NH_2 \cdot C_9H_6$ N. H_2SnCl_4 requires Sn = 29.8 and Cl = 35.42 per cent.

5-Amino-quinoline Stannichlorire

$NH_2 \cdot C_9H_6$ N. H_2SnCl .

Three grams of 5-Nitro-quinoline were warmed with 12 grams of stannous chloride and 80 cc. of concentrated hydrochloric acid diluted with 50 cc. of water. When the reduction was complete, the resulting solution was cooled and deposited orange crystals. These were recrystallised from hot dilute hydrochloric acid.

5-Amino-quinoline stannichloride dissolved in water, but the solution became cloudy on warming. The solution was strongly acid; it gave no precipitate with mercuric chloride, but yellow stannic sulphide was obtained by passing in hydrogen sulphide.

Hot methyl- and ethyl alcohols dissolved the salt, but it was insoluble in other organic solvents. When heated it melted to a pale brown liquid at 242°.

On analysis:—

0.4965 grm. gave 0.121 0grm. SnO_2;
Sn = 24.25 per cent.
0.4691 grm. gave 0.8120 grm AgCl;
Cl = 42.8 per cent.
$NH_2.C_9\ H_6$ N. H_2SnCl_6 requires Sn = 24.43 and Cl = 43.5 per cent.

6-Amino-quinaldine Stannochloride

$C_{10}H_{10\ 2}$, H_2SnCl_4.

6-Nitro-quinaldine was obtained in very satisfactory yield (about 85 per cent.), from p-nitroaniline, hydrochloric acid, and paraldehyde by the method described by Hamer (*J.C.S.*, 1921, CXIX., 1435). It was recrystallised from alcohol and two grams were treated with four grams of tin and 60 cc. of hydrochloric acid diluted with an equal volume of water. A clear colourless solution resulted after warming for an hour. When cold the solution deposited feathery crystals on stirring. These were filtered with some difficulty, a felted mass resulting which was deliquescent. This was recrystallised from dilute hydrochloric acid, and the crystals were washed with alcohol and dried on a porous tile in a desiccator over solid sodium hydroxide.

6-amino-quinaldine stannochloride dissolved very readily in cold water. The solution remained clear until heated. With mercuric chloride solution it gave a white precipitate which turned grey, indicating that the salt contained stanous tin. The precipitate obtained on adding hydrogen sulphide water to a solution of the salt was dark brown.

The salt dissolved in boiling glacial acetic acid, and also slightly in boiling ethyl alcohol with amyl alcohol a deep red colour was developed on heating. It was insoluble in benzene, acetone, chloroform and ether. When heated it began to decompose at about 180°.

On analysis:—

0.4287 grm. gave 0.1139 grm. SnO_2;
Sn = 20.88 per cent.
$C_{10}H_{10}N_2.H_2SnCl_4$ requires Sn = 20.55 p.c.

6-Amino-quinaldine Stannichloride.

$C_{10}\ H_{10}\ N_2$, H_2 Sn Cl_6

6-Nitro-quinaldine (two grams) was treated with 7.5 gram Stannous chloride and 50 cc. of concentrated hydrochloric acid diluted with twice this volume of water. The mixture was heated until it became a clear and colourless solution, which deposited colourless nacreous platelets on cooling.

This salt dissolved readily in cold water

to a clear solution which gradually deposited a white flocculent precipitate of hydrated stannic oxide. This precipitate appeared very readily on boiling the solution. Hot alcohols dissolved the salt, but it was insoluble in other organic solvents. The amyl alcohol solution was a deep red colour.

It melted with decomposition on heating to 224°-228°.

On analysis:—

0.7025 grm. gave 0.1703 grm. SnO_2;
Sn = 19.1 per cent.

0.2170 grm. gave 0.2818 grm. AgCl;
Cl = 32.1 per cent.

$C_{10}H_{10}N_2, H_2SnCl_6$ requires Sn = 18.30 and Cl = 32.78 per cent.

Isoquinoline Stannichloride
$(C_9H_7N)_2.H_2SnCl$.

This salt was prepared by adding 5.2 grams of the base to a solution of 5.25 grams of anhydrous stannic chloride in 200 cc. of dilute hydrochloric acid. The mixture was boiled for a few minutes and the very pale pink solution so obtained was then cooled and deposited a mass of fine, almost colourless, prismatic crystals.

These were filtered at the pump, drained and dried. They were recrystallised from hot dilute hydrochloric acid.

On heating the crystals began to darken at about 240° and melted at 265°. At higher temperatures a white sublimate was formed and this, like many similarly obtained from other stannichlorides, contained tin.

Isoquinoline stannichloride was somewhat soluble in cold water, more readily so in hot water, but in this case hydrolysis took place, the solution being strongly acid, emitting the odour of the free base and depositing a flocculent precipitate. The salt dissolved slightly in methyl and ethyl alcohols on warming, and in glacial acetic acid and hot nitrobenzene, but other organic solvents did not dissolve it.

On analysis:—

0.5147 grm. gave 0.1302 grm. SnO_2;
Sn = 19.82 per cent.

0.1822 grm. gave 0.2583 grm. AgCl;
Cl = 35.11 per cent.

$(C_9H_7N)_2.H_2SnCl_6$ requires Sn = 20.05 and Cl = 35.95 per cent.

[CONTRIBUTION FROM THE DEPARTMENT OF THE UNIVERSITY OF NORTH CAROLINA.]

ZIRCONIUM FERROCYANIDE AND FERRICYANIDE.

By F. P. VENABLE AND E. O. MOEHLMANN.[1]

(From the "Journal of the American Chemical Society.")

There are only casual references in the literature to the possible existence of zirconium ferrocyanide and ferricyanide, and these concern mainly their use as qualitative tests.

Some of the older texts state that potassium ferrocyanide gives a yellow precipitate in neutral solutions of zirconium salts. De Boisbaudran[2] stated that this precipitate was given also in acid solutions even when very dilute. Of course, on account of hydrolysis a neutral solution would remain such only for a very brief time. Before this Hornberger[3] had gone into the matter more in detail and reported the precipitate as yellow-white and insoluble in excess of the precipitant. When precipitated hot the yellow colour became yellow-blue and the odour of hydrogen cyanide was detected. When dried it was blue with a touch of green. It was insoluble in water but soluble in acids with evolution of hydrogen cyanide. For analysis he dissolved the precipitate in sulphuric acid diluted with 25 per cent. of water. From his results he calculated the formula, $3Zr(CN)_2.2Fe(CN)_6$ which he compared with Turnbull's Blue, $3Fe(CN)_2.2Fe(CN)_6$. This, as he remarked, involved the assumption of bivalent zirconium.

Zirconium Ferrocyanide.—In the following experiments 0.1 *M* solutions of zirconium oxychloride, $ZrOCl_2.8H_2O$, and potassium ferrocyanide were prepared. The first was freshly prepared. The precipitate formed on addition of potassium ferrocyanide was white and flocculent or curdy. It was insoluble in excess of either reagent and unchanged in colour. On prolonged exposure or drying in the air the colour changed from yellow to blue and bluish-green. The precipitate remains white for some time when covered with cold, boiled water. It cannot be filtered to approximate dryness without changing colour. The zirconyl chloride used was very nearly free from iron. The changes in colour are doubtless due to decomposition and freeing of iron from partial decomposition of the ferrocyanide.

The fresh precipitate is soluble in conc. sulphuric acid. Decomposition, however, is indicated by changes of colour. This is avoided by making a smooth paste of the ferrocyanide with water, then dissolving

1 *From a thesis presented in partial fulfilment of the requirements for the degree of Bachelor of Science.*

2 *De Boisbaudran, Compt. rend.*, 94, 6125 (1882).

3 *Hornberger, Ann.* 181, 232 (1876).

in acid and diluting to about ¼ strength. Acid of this strength directly applied fails to effect solution. When ammonium hydroxide is added to complete precipitation, but in as slight excess as possible, a precipitate of zirconium hydroxide $Zr(OH)_4$ is obtained and the ammonium ferrocyanide and sulphate are removed in the filtrate. The precipitate was dried and ignited to the dioxide. The filtrate and washings were combined and titrated by standard potassium permanganate.

Two sets of analyses were performed in duplicate with products from solutions at room temperature, the zirconyl chloride solution being used immediately after preparation. The first contained 0.8 gr. of $ZrOCl_2.8H_2O$ and the second 2.0 gr.

Expt. 1 a. $ZrO = 0.0730$; $Fe(CN)_6 = 0.0463$; ratio 1.57

b. $ZrO = 0.0719$; $Fe(CN)_6 = 0.0466$; ratio 1.54

Expt. 2 a. $ZrO = 0.2767$; $Fe(CN)_6 = 0.1987$; ratio 1.39

b. $ZrO = 0.2779$; $Fe(CN)_6 = 0.1958$; ratio 1.41

In a third experiment the zirconyl chloride solution was first boiled so as to become thoroughly hydrolysed, and then was cooled.

Expt. 3 a. $ZrO = 0.1450$; $Fe(CN)_6 = 0.0424$; ratio 3.42

b. $ZrO = 0.1436$; $Fe(CN)_6 = 0.0431$; ratio 3.33

When water is present no normal zirconium salt can be formed; zirconyl salts are found instead, or basic zirconyl salts more or less hydrolysed under the influence of dilution, time and temperature. Taking certain hypothetical salts for purpose of comparison it is seen that $(ZrO)_2Fe(CN)_6$ has the ratio 1.01; $ZrO(OH)_2.(ZrO_2Fe(CN)_6$ 1.51; $3ZrO(OH)_2.4(ZrO)_2Fe(CN)_6$, 1.39; $9ZrO(OH)_2.2(ZrO_2Fe(CN)_6$, 3.27. The analytical results show that the hydrolysis proceeded too rapidly under the conditions of the experiments to yield zirconyl ferrocyanide, $(ZrO_2Fe(CN)_6$. Only basic ferrocyanides were obtained corresponding to different stages in the hydrolysis.

Zirconium Ferricyanide. — The older texts report that no precipitate is formed when a solution of potassium ferricyanide is added to solutions of zirconium salts. Rose,[4] however, reported such a precipitation.

It was found that no precipitate was formed when 0.2 *M* solutions of zirconyl chloride and potassium ferricyanide were mixed, nor were precipitates obtained when more concentrated solutions were used, nor when either salt was added in excess. When such mixtures were slowly evaporated in a desiccator the only crystals formed were those of potassium ferricyanide. The rest of the mass was amorphous and varicoloured from green to blue and darkening almost to black. This we interpret as indicating that zirconyl ferricyanide, if formed, is too soluble to appear as a precipitate and is easily decomposed. Similar results were obtained when solutions of zirconyl sulphate were used.

The formation of a basic zirconyl ferricyanide is much easier, however, and this accounts for the observation of Rose. When dilute solutions of zirconyl chloride are strongly hydrolysed by boiling and potassium ferricyanide then added, a bright yellow, flocculent precipitate was obtained which, like the ferrocyanide, changed to green, blue, and almost black on drying.

Two gr. of zirconyl chloride octahydrate was dissolved in 100 cc. of water, the solution boiled for 30 minutes, cooled and precipitated with as little excess of potassium erricyanide as possible. The precipitate was washed by decantation with about 3 litres of water. This was found more easily soluble and in somewhat more dil. sulphuric acid than the ferrocyanide previously described and the solution remained unchanged for some days, in which also it differed from the ferrocyanide. The solution was diluted about 10-fold, sodium hydroxide added in very slight excess, the zirconium hydroxide filtered off, ignited and weighed as the dioxide. The ferricyanide radical was determined volumetrically by reduction to ferrocyanide and titration with standard potassium permanganate. In a second set o experiments, 4 gr. of zirconyl chloride octahydrate was used. In both sets the results were checked by using aliquot parts for the analyses

		ZrO G.	Fe(CN)6 G.	Ratio
I	a.	0.1724	0.0255	6.762
	b.	0.1726	0.0185	9.326
II	a.	0.5276	0.0774	6.815
	b.	0.2788	0.0409	6.812
	c.	0.2619	0.0383	6.847

The result for ferricyanide in Set Ib was rejected as faulty from some error in analysis. Omitting this, therefore, the average

4 Rose, *Ann. Phys. Pogg.*, 48, 575 (1840).

ratio is 6.809. Calculating this ratio from a hypothetical hydrolysed zirconium ferricyanide $mZrO(OH)_2.n(ZrO)_3Fe(CN)$ the ratio at which m and n are both unity equals 2.012; when $m = 10$ and $n=1$ the ratio is 6.540; when $m=11$ and $n=1$ the ratio is 7.043; when $m=21$ and $n=2$ the ratio is 6.791. The results indicate a constancy of proportion too great for an indefinite adsorption compound and so the formation of a definite very basic compound in which the acid radical is retained even after repeated washings with water. The most probable formula would be $21ZrO(OH)_2.2(ZrO)_3Fe(CN)$. In this less than 1/10 as much acid is left as is present in the compound representing the first stage of hydrolysis from the normal zirconium ferricyanide.

SUMMARY.

1. *Precipitates are formed when potassium ferrocyanide is added to solutions of zirconium salts. These are basic zirconyl ferrocyanides, unstable in the air, and* their composition depends upon the extent of hydrolysis. Thus, a freshly prepared solution of zirconyl chloride gives a substance of the formula, $ZrO(OH)_2.(ZrO)_3Fe(CN)_6$, and one that has been hydrolysed by boiling gives a substance of the formula, $9ZrO(OH)_2.2(ZrO)_2Fe(CN)$.

2. Potassium ferricyanide gives no precipitate in freshly prepared solutions of zirconyl chloride. After boiling, the very basic compound $21ZrO(OH)_2.2(ZrO)_3Fe(CN)$ *is precipitated.*

Chapel Hill, North Carolina.

GENERAL NOTES.

BOARD OF TRADE ANNOUNCEMENT.

SAFEGUARDING OF INDUSTRIES ACT—PART I. FINAL DECISION IN REGARD TO GALLIC ACID.

The Board of Trade announce that the Referee, after hearing a complaint under the above Sub-Section that Acid Gallic had been improperly excluded from the lists of articles chargeable with duty under Part I. of the Safeguarding of Industries Act, has given judgment upholding the complaint; and accordingly the lists issued by the Board are amended so as to include the item "Acid Gallic," as from and including the 21st October, 1922.

It may be recalled that Gallic Acid was in the original list as drawn up by the Board of Trade. In consequence, however, of certain observations by the Referee in regard to the removal of Cream of Tartar, the Board of Trade also deleted Gallic Acid. The effect of the final decision of the Referee, as given above, is to restore Gallic Acid to the list as originally drawn up by the Board.

Board of Trade,
19th October, 1922.

DYESTUFFS ADVISORY LICENSING COMMITTEE.

The Board of Trade announce that, following upon the resignations of Sir Harry V. Kilvert, J.P., Mr. G. W. Currie, and Dr. M. O. Forster, F.R.S., F.I.C., from the Dyestuffs Advisory Licensing Committee ,which was originally set up in January, 1921, pursuant to passage of the Dyestuffs (Import Regulations) Act, 1920, Sir Thomas Robinson, C.B.E., M.P., has been appointed Chairman, and Mr. R. Waddington, M.P., and Professor G. T. Morgan, F.R.S., F.I.C., members of the Committee.

METALLURGICAL RESEARCH.

Professor Thomas Turner, in his presidential address to the members of the *Metallurgical Society of the University of Birmingham*, on Wednesday last stated that a large amount of research work was done there last year. It had relation particularly to experiments in steel and non-ferrous metals, and to the properties of refractories and fire-clays. The researches had been of a high character, as was evidenced by the way they had been received by competent authorities. "The Turner Medal" and £10 worth of books was presented to Mr. Harold Wiggin, for his work during the year. This prize was the outcome of an anonymous donation of 500 gs. as an expression of appreciation of the researches made under the direction of Prof. Turner.

MEETINGS OF SOCIETIES.

ROYAL SOCIETY.

List of papers read on Thursday, Nov. 2nd, 1922:—

LORD RAYLEIGH, F.R.S.: *Polarisation of the Light scattered by Mercury Vapour near the Resonance Periodicity.*

G. P. THOMSON: *The Scattering of Hydrogen Positive Rays and the Existence of a powerful Field of Force in the Hydrogen Molecule.* Communicated by Sir J. J. Thomson, F.R.S.

H. D. SMYTH: *A new Method for studying Ionizing Potentials.* Communicated by Sir E. Rutherford, F.R.S.

I. BACKHURST: *Variation of the Intensity of reflected X-radiation with the Temperatuer of the Crystal.* Communicated by Sir W. Bragg, F.R.S.

S. DATTA: *The Absorption Spectrum of Potassium Vapour.* Communicated by Prof. A. Fowler, F.R.S.

K. R. RAMANATHAN: *The Molecular Scattering of Light in Vapours and in Liquids and its Relation to the Opalescence observed in the Critical State.* Communicated by Dr. G. T. Walker, F.R.S.

THE CHEMICAL SOCIETY.

ORDINARY SCIENTIFIC MEETING, HELD ON THURSDAY, NOVEMBER 2ND, 1922, AT 8 P.M.

The following papers were read:—

The solubility and volatility of the nitrobenzaldehydes. N. V. SIDGWICK and W. M. DASH.

Investigations on the dependence of rotatoyr power on chemical constitution. Part XIII. *The spatial configuration of the unbranched aliphatic chain.* R. H. PICKARD, J. KENYON and H. HUNTER.

Investigations on the dependence of rotatory power on chemical constitution. Part XIV. *The normal aliphatic ethers of d-β-octanol.* J. KENYON and R. A. MCNICOL.

Investigations on the dependence of rotatory power on chemical constitution. Part XV. *The normal aliphatic ethers of d-methyl benzylcarbinol.* H. PHILLIPS.

Investigations on the dependence of rotatory power on chemical constitution. Part XVI. *A new type of Walden inversion.* H. PHILLIPS.

Investigations on the dependence of rotatory power on chemical constitution. Part XVII. *The di-d-β-octyl esters of the acids of the general formula* $(CH_2)_n(COOH)_2$. L. HALL.

Orientation of the 1:4- and 1:5-dimethylglyoxalines. Mode of fission of 5-aminoglyoxalines. F. L. PYMAN.

Bromo-derivatives of 2-methylglyoxaline. L. LIGHT and F. L. PYMAN.

THE OPTICAL SOCIETY.

The programme of the Optical Society for the current session includes the following lectures, dealing with the evolution and development of optical instruments and apparatus: "The history of the photographic lens," by Dr. R. S. Clay, on 9th November, 1922; "The birth of cinematography and its antecedents," by Mr. Will Day, on 25th January, 1923; "Surveying and nautical instruments from a historical standpoint," by Dr. L. C. Martin, on 22nd March, 1923; and "Telescopes from a historical standpoint," by Mr. D. Baxandall, A.R.C.Sc., on 24th May, 1923.

The lectures will, in each case, be illustrated by a series of unique instruments of historic interest from various collections.

The meetings will be held at 7.30 p.m. on the dates specified, at the Imperial College of Science and Technology, South Kensington.

NOTICES OF BOOKS.

Filtration, by T. ROLAND WOLLASTON. Pp. X. + 102. London: Sir Isaac Pitman & Sons, Ltd., Parker St., Kingsway, W.C. 1922. Price 2s. 6d.

In this volume of Pitman's Technical Primer Series, Mr. Wollaston has given a concise and clear account of the various industrial methods of filtration. He has collected much information especially useful for those chemists, engineers and others concerned with public health and water supply.

Various systems for the filtration of liquids and gases are described very clearly, and although merely claiming to be an elementary treatise, the book contains much of value to specialists.

It will be found very serviceable by those who can afford little time to consult and wade through large treatises for information on any point in connection with this subject.

The definition of *Permanent Hardness* of water, given on p. 4, is hardly exact, but no other inaccuracy has been noticed during a careful perusal of the book.

Die Methoden zur Herstellung Kolloider Lösungen Anorganischer Stoffe, von DR. THE SVEDBERG. Pp. XII. + 508 + 3 plates. Dresden and Leipzig: Verlag von Theodor Steinkopff. 1922. Price 13s. 2d. unbound, 14s. 2d. bound.

Dr. Theodor Svedberg's valuable compilation on the methods for preparing substances on the colloidal state has now reached its third edition.

The methods for the preparation of colloidal solutions may be broadly divided into two kinds, Condensation Methods and Dispersion Methods. In the former, the

author includes the methods of reduction, oxidation, hydrolysis and certain special processes.

A very complete bibliography accompanies each section of the various processes and the author has not hesitated to quote extensively, where appropriate, from the original sources.

The most important methods of general application are compactly summarised in the form of tables at the end of each section which is further divided into a general and historical part, and a special or descriptive part.

It is interesting to note that the first edition in 1909 cost 16s. unbound and 18s. bound, whereas the present edition costs in England 14s. 2d. bound.

The book will find its way into most chemical and scientific libraries. Many chemists and physicists will also find it indispensable.

Researches on Cellulose, IV. (1920-1921), by CHARLES F. CROSS and CHARLES DOREE. Pp. X. + 253 + 4 plates. London: Longmans, Green & Co., 39, Paternoster Row, E.C. 1922. Price 15s.

The study of Cellulose is a vast one and covers a very wide field indeed, and the authors of this fourth volume of Researches on Cellulose have undertaken a great and useful task in selecting and compressing into 250 pages the really important advances in this field during the last decade.

Their theme is that cellulose must be considered as something more than a molecule represented by a formula. They admire and record the brilliant structural work of pure chemists that has assisted towards the elucidation of some of the problems connected with this body. By closing with 1921 they have been unable to refer to the work of Principal J. C. Irvine in his address to the British Association (which appeared in the *Chemical News*, Sept. 22, p. 165 *et seq.*, of this volume), which has practically settled the constitutional controversy.

They have recorded the important researches on the hydrolytic degradation of cellulose, including Miss Cunningham's "Re-investigation of the Cellulose Dextrose Relationship." The authors point out that it is very easy to alter cellulose in the course of purification, such substances as oxy-cellulose and hydrocellulose being produced. All past technical advances in the cellulose industries have been the achievements of those who have regarded it as an organised vegetable structure as well as a chemical product. Especially is this noticeable in the manufacture of artificial silk by the "Viscose" process, which may lead to many industrial developments.

The sections on the analysis of woods and on the bacterial resolution of celluloses are noteworthy, since they give the results of new and very original work. Unpublished researches by the authors on ligno-cellulose have also been included. It amplifies their contention that a fractional combination changes the whole mass of the cellulose.

The work on hemi-celluloses and colloidal cellulose properties has received adequate treatment. In the chapter on Physical properties of wood celluloses and their prominence is given to the recent work on the solvent action of aqueous solutions of neutral salts on cellulose, by H. E. Williams.

The slip-plane work of W. Robinson also has very important bearings upon the physical proerties of wood celluloses and their industrial applications.

In this volume the authors have adopted the Chemical Society's method of quoting references. The general adoption of this system would be very welcome.

The authors are both very well-known authorities in this branch of organic and applied chemistry. Their book makes no claim of being exhaustive, yet it gives a good and accurate account of the real progress that has been made in this subject.

J.G.F.D.

BOOKS RECEIVED.

The Manufacture of Dyes, by JOHN CANNELL CAIN, D.Sc. Pp. IX. + 274. 1922. Messrs. McMillan & Co., Ltd., St. Martins Street, W. 12s. 6d.

Chemical Engineering Catalog. COMMITTEE OF THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS. Pp. 1,187. Seventh Annual Edition. 1922. The Chemical Catalog Co. Inc., 19, East 24th Street, New York. 10 Dollars.

PAMPHLETS.

SCIENCE BY DEFINATION SERIES.

By F. H. Loring.

(1) *Definition of Relativity*. Pp. 16.
(2) *Definition of the Æther*. Pp. 16.
(3) *Definition of Equivalence*. Pp. 16.
(4) *Definition of Isotopes*. Pp. 20.

Published by H. O. Lloyd & Co., Ltd.,

327, Upper St., N.1, at 1s. each.

The object of this series is to give in concise form, definitions of current scientific terms, words or ideas, so that the reader may acquire a better understanding of their purport, and thereby be able to dip deeper into the literature which is growing so rapidly owing to the world-wide activities in pure science.

In framing these "definitions" the author has drawn from the works of authors of recognised authority, so that complete originality is not claimed.

Whilst interest in Relativity continues unabated, those desirous of obtaining a clear conception of the fundamental principles may, with advantage, study No. 1 of Mr. Loring's series. This applies to students and to others whose chief interests have led them from the mathematical sciences.

Indeed, these pamphlets might form a convenient introduction to the study of Relativity.

No. 2 has appeared at an opportune moment. At a time when wireless broadcasting is so extensively in operation, a consideration of the medium which is supposed to act as a carrier of the wave energy becomes of great general interest.

The subject is admittedly a difficult one, because the ether gives no direct clue to its existence, *i.e.*, the strongest argument in favour of an all-pervading ether is based upon analogy.

The 20 pages on explanation of the existence of "Isotopes" are very good. The very latest information upon this important subject is included. The author has incorporated some of the material from his communications to *The Chemical News*, and also refers to the valuable results obtained by well-known experimentalists in this field.

Mr. Loring states that more pamphlets of this kind are in preparation, and their publication is awaited with interest.

Much confusion in the meaning of terms used differently by, say chemists and physicists, has arisen, and the series should serve a useful purpose in enabling general readers to obtain accurate impressions of the various phrases and terms now coming into scientific use.

The Evolution of Atoms and Isotopes, by W. D. VERSCHOYLE, published by J. J. Keliher & Co., Ltd., Craven House, Kingsway, W.C.2, at 1s. 9d.

The author has divided his booklet of 40 pages into two parts.

He commences with a glossary of the new terms used in "Sub-Atomic" Chemistry. A complete list of the known and suspected elements is given with the symbols and latest Atomic Weights.

The subject is discussed with the aid of tables and diagrams illustrating the author's interesting views on the evolution of the atoms and isotopes. He has drawn his conclusions from the experimental results and conclusions of the distinguished researchers in this branch of science.

His views and scheme of evolution will probably encounter opposition, and will not be readily accepted, but is certainly worthy of the careful consideration of all who are interested in this subject.

New Patents.

This list is specially compiled for the *Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

26967—Coke & Gas Ovens, Ltd.—Method of producing white commercial pure ammonium chloride. Oct. 5.

27083—Dreyfus, H. Manufacture of products from alkali compounds. Oct. 6.

27107—Holzverkohlungs Industrie Akt-Ges.—Process for chlorination of methane. Oct. 6.

26883—Hovey, E. L.—Nitrate of lime. Oct. 5.

26739—Hovey, E.—Process for production of hydrogen sulphide. Oct. 3.

26722—Jackson, W. J.—Manufacture of hydrogen sulphide.

Specifications Published this Week.

160777—Acree, S. F.—Methods of converting wood into mucic acid and other products.

186144—White, A. E.—Manufacture of white lead.

186107—Imray, O. Y.—Manufacture of resins.

186118—Thompson, W. P.—Lead alloys.

Abstract Published this Week.

Oxalic Acid.—Patent No. 184627.—An improvement in the process of producing Oxalic Acid has been Patented in this country by Messrs. Badische Anilin & Soda-Fabrik, Ludwigshafen-on-Rhine, Germany.

Wood or other material containing cellulose is treated with nitric acid, or with oxides of nitrogen and water, in the presence of a catalyst which may consist of a compound of iron, of rare earths or their compounds, or of magnesium compounds. In examples, nitric acid solutions of iron nitrate or of didymium nitrate are used at temperatures of about 60° C. With magnesium compounds higher temperatures are used, so that the salt is melted in the presence of water. The nitric acid may be supplied from magnesium nitrate when employed as catalyst, by heating it to about 160-170° C. and gradually adding the wood to the fused salt. When magnesium chloride is used nitric acid is added and the temperature raised to about 170-190° C.

Messrs. Rayner & Co. will obtain printed copies of the published specifications, and forward on post free for the official price of 1s. each.

The Ramsey Memorial Tablet

UNVEILED IN WESTMINSTER ABBEY ON FRIDAY, THE 3rd NOVEMBER, BY HIS ROYAL HIGHNESS, THE DUKE OF YORK.

We are pleased to record that the name of Sir William Ramsay has been fittingly honoured by the erection of a tablet in Westminster Abbey.

Those of us who knew him feel that the honour is well deserved; he was a brilliant investigator, an indefatigable worker, a kindly teacher, and a warm-hearted gentleman.

The unveiling service was attended by a large nmmber of his friends, and after the ceremony His Royal Highness was presented with the Ramsay Memorial Gold Medal by His Excellency the French Ambassador.

THE CHEMICAL NEWS,

VOL. CXXV., No. 3265

FEDERATION OF BRITISH INDUSTRIES.

Speech by Colonel O. C. Armstrong (President), at the Caledonian Hotel, Edinburgh, October 31st, 1922.

When you kindly invited me to visit you we none of us anticipated that the date you had chosen would so closely coincide with that of a General Election.

Necessity for Rigid Economy and Reduction of Taxation.

As you are well aware, the Federation takes no part or hand in politics. There is, however, one question which affects the whole of the community, and this prospective members of all parties should be called upon to answer before they receive support at the polls, namely, whether they will use their utmost strength to support a policy which will enforce on the Government rigid economy, and demand that such economies be in greater part applied to the reduction of the intolerable burden of taxation under which we are now suffering. I would ask all members of the Federation who are present here to-day, whatever their political creed may be, to insist that the candidate to whom they intend to give their vote should give frank, clear and definite pledges that he will further such policy if he be elected.

It is impossible for industry to improve its position so long as it is overweighted with taxation, both national and local. If this burden is to be lightened it will be incumbent on the new Government to make far more serious effort than their predecessors have done to reduce expenditure. It is a difficult and unpleasant mandate to carry out. Economy is popular in principle, but it is desperately unpoular in its application especially among those who are called uon to make sacrifice either in person, or in the deferment of some of their cherished ideal schemes of betterment. Unfortunately at present the welfare of the entire community is dependent on the acceptance of such sacrifice. The new Government will not only need great courage but must also be prepared to be at least for some time one of the most unpopular administrations which this country has ever possessed.

Prospects of Trade Revival.

The Government may possibly find compensation and encouragement in its acceptance of this unpleasant role in the fact that the industrial outlook is not quite so gloomy as it has been for the last eighteen months. At the moment there are slight indications that the clouds are breaking though they are not lifting. There are slight signs of a revival in a certain number of industries. One can only express the most sincere hope that these faint signs may multiply, become more definite and of wider extent to such degree that one may find sufficient justification to forecast that a steady and general upward trend is in progress. Only when such movement is steady and simultaneous will it be possible to maintain that we are nearing the end of the slump and approaching the commencement of better times.

Should these portents materialise, it will be up to us individually and collectively to concentrate all our energies towards in-

creasing the momentum of the movement. We shall perhaps be in a better position to exert such energy in that the evil days we have passed through have taught us salutary lessons, among others the stern need for the lowering of the cost of production if we are to regain our place in the world's trade. Much has already been done in this direction, and I think and sincerely hope I am justified in saying that with a possible revival of trade in sight we shall be able to rely on even greater co-operation on the part of labour than we are at present counting upon.

Railway Rates, Dock Charges and Freights.

Besides the factors I have already referred to, there are other direct causes which seriously penalise our trade. Among the more important of these, I would cite railway rates, dock charges and freights. With improved trade, more economic administration and lower working costs, there is no doubt that all these charges can be very materially reduced. The present scales constitute an intolerable handicap, and it is incumbent on us to continue to press for further serious reductions also for a removal of the many existing anomalies in reights, which in certain cases result in preferential rates being given to goods shipped from Continental ports.

It is within your knowledge that the Federation recently took the decisive lead in inducing the Railway Companies, both English and Scottish, to reduce their rates. Similarly pressure is being brought to bear by the Federation to effect a reduction in dock charges. I can assure you that with your assistance and support the Federation will continue its efforts to bring about such readjustments in transit charges as will prove beneficial to the interests of our trade.

Difficulties in European Markets and Effect of Exchanges.

The chief difficulty which lies in our way is the condition of the majority of our European markets. Most are suffering from exchanges so depreciated that buying from Great Britain becomes almost an impossibility. Some of them, such as Russia, are virtually shut off from us. It is interesting to recollect that in 1913 Russia, Austria and Germany purchased from this country £63,000,000, or 12 per cent. of our total exports.

Adjustment of Reparations an Essential Antecedent to Recovery of Exchanges.

The more one considers this question, the more one is forced to the conclusion that an essential antecedent to the stabilisation of the exchanges is a reconsideration and a readjustment of the reparation claims. However much the Germans may have been to blame in the earlier days for the depreciation of the mark, there can be little doubt now that inflation has run away with them until at the present moment they are on the verge of a complete financial collapse, owing to the fact that thet mark, at 20,000 to the £, is beginning to go out of effective circulation.

A bankrupt Germany so far from assisting towards any possible solution will only complicate it and render our position in this country worse than it is at present, since in its train it will inevitably drag the financial position of France, Belgium, and other countries to a lower level than that at which they now stand.

While holding that Germany should be made to pay every penny that she can possibly afford, we have to-day to face the question more from a practical than a moral point of view. We are now being forced to realise that the stabilisation of European exchanges depends upon Germany's position and that we must consequently revise the reparation claims, definitely decide how much she may be able to pay within a certain date, to concede to her a moratorium for the necessary period of time, Germany, on the other hand, giving satisfactory assurances that she will balance her budget, close her printing press, and set her house in order. I believe that the feeling of alarm at the sudden collapse of her currency valnes is of sufficient extent to ensure her in her own interests taking steps in this direction if only the question of reparations can be adjusted on a practical basis.

Plain Speaking and Acceptance of Realities.

To my mind the one way in which this can be done is at a round table conference, where plain speaking is allowed to prevail and the acceptance of unpleasant realities admitted. There are obviously very great difficulties in bringing such a conference to a successful conclusion, but our friends the French must realise that the point has been reached at which, if they maintain

their impossibly intransigeant attitude, their interests in reparation payments will disappear, and they will not obtain from Germany even the lesser amount which might now accrue to them by the acceptance of a prompt and reasonable compromise.

The situation has now become so serious, the contingent effects so widespread, that immediate and drastic action is necessary. Every effort should be made to induce the new Government to deal with this question forcibly and at the earliest possible opportunity. It is inevitable that any understanding which may be come to will imply a prolonged moratorium in regard to the debts due to us by our Allies. Though we are in no way prepared to cancel these obligations, nevertheless we should readily agree to any deferment that may be necessary, if by so doing we can secure co-operation in the first step towards stabilising exchanges.

Hostile Tariff Barriers.

A further retarding influence on our recovering certain markets lies in the hostile tariff barriers which are being put up by many of our former friends. Apart from the question of the American Tariff, which raises its own particular difficulties, there has been a general tendency throughout the world since the close of the war to raise higher and higher tariff walls, and even in those countries to which exchange and other conditions render it possible to export, these tariffs have become a serious detriment to British trade.

For some time the Federation has been keeping his aspect in regard to particular countries and particular tariffs before the attention of H.M.G. They have supplied the Departments concerned with these matters with fuller information than they have ever received before as to the effects of these tariffs upon industry. I am glad to think that in such matters as the recent Treaty negotiations with Spain, the assistance this Federation was able to render, both in preparing the way by a special unofficial mission for the more formal official negotiations, and by supplying advice and information during the negotiations, has been one of the principal factors in securing a comparatively satisfactory result, and that the spade work which has been done in regard to other countries and their tariffs may well bear fruit during the coming year.

Nevertheless, I consider that it will be one of the more important tasks of the Federation during the forthcoming year to urge upon our Government that they should apply both more serious attention and more vigorous action to breaking down these barriers which are impeding the recovery of our trade.

Bteter Prospects in Markets Outside Europe.

As regards foreign markets in general, it appears to me that we should in the immediate future look outside Europe, for instance to S. America and the Far East, for any substantial increase in our export trade. There are certain factors in existence which may be of considerable assistance to us.

The force of German competition is weakening as her financial position becomes worse: while the present U.S. policy in regard to both tariffs and the inter-allied debts will have a considerable reaction upon their power to compete in external markets.

There remains one market, the possibilities of which are being widely canvassed at the present moment. I refer to the British Empire.

The Empire: Limiting Factors to an Immediate Extension of Trade.

In the Empire, we have great natural advantages in similarity of ideas, identity of language, and relatively favourable tariff and exchange conditions, and from the broad Imperial point of view there can be no possible doubt that every step we take for the furtherance of inter-Imperial trade will in the long run redound to the benefit of the Empire as a whole and of each constituent part. But we must remember that there are many limiting factors to any immediate increase of that tarde, and that we must not pitch our hopes too high.

Recent discussions have referred more particularly to our Overseas Dominions, namely, Australia, New Zealand, Canada, and the Union of S. Africa. Now the population of these four Dominions only amounts to 22,000,000.

Although we know that the purchasing power per head in most of the Dominions is high (in 1921 they took 15½ per cent. of our exports), there is an obvious limit to the absorbing capacity of markets with a relatively small population. Again, there

must be limits to the productive power of areas, however vast their potential resources, unless those resources can be developed by an adequate population.

It would be unreasonable to expect that we could make a very substantial increase in our trade with these Dominions until sufficient time has elapsed for them to increase their populations.

LOCAL INDUSTRIES IN DOMINIONS SHOULD BE ASSISTED.

That such increases will serve to add strength to the present movements towards fostering local industries is inevitable. *We must regard this movement* from the broadest point of view, we must welcome it and assist it actively by ensuring that such developments are effected by the support of British capital, lest we find that, as is already the case to consider the extent in Canada, that capital has been supplied by competing countries. If a sane and healthy development of local industries takes place with the assistance of British capital and with due regard to the real industrial potentialities of the Dominions concerned, such a development can only tend to increase the general level of prosperity and consequently the growth of our trade with such Dominions.

NECESSITY FOR INCREASE OF POPULATION.

These conditions are all dependent upon an increase of population, and it is of the greatest importance that the Government should, in co-operation with the Dominion Governments, expand and perfect schemes of emigration to those parts of the Empire which are in need of additional population. For these reasons we cannot look to those Dominions for any immediate assistance in facing the problem of our foreign markets. We cannot, therefore, afford meanwhile to relax our endeavours in other parts of the world.

In India, we are faced with the difficulties of the political situation and possibly of a fiscal policy which may hamper any extenson of British trade. In regard to India I am afraid we can only say that the prospects of an immediate increase of our trade must be slight, and that we may even find difficulty in maintaining it at its present level.

I am a firm advocate of doing everything which is possible to stimulate and develop our trade within the Empire. I look to this trade to be eventually the solution of many of our present problems, both economic and political. I believe that every effort should be made to stimulate such trade, and to lay the foundations for its increases, but we must realise that such an increase can only be gradual, that thought and labour must be given to the solution of the problems involved, and that we shall have need of much patience before we see the fruits of our efforts. We must remember that the development of the consumption power of any market is necessarily slow and dependent upon the power of that market to develop its own production so that the consumption can be paid for.

Whether this development will proceed *smoothly, and upon sound and healthy* lines, will depend very largely upon the wisdom and foresight of all concerned, and particularly, perhaps, on those responsible for the financial and general policy of the Dominions themselves. Development will not be assisted if we in this country rush into ill-considered schemes, or if through a lack of appreciation of the legitimate needs and ambitions of the Dominions themselves, we attempt to force upon them schemes based too much upon our own present necessities.

A SIMPLE MATHEMATICAL CONCEPTION OF THE DENSITY OF THE ELEMENTS.

By LEON A. CONGDON

(Chemistry Department, Syracuse University, Syracuse, New York).

INTRODUCTION.

Perhaps no other physical property of the elements has puzzled the chemist and physicist more than density, or as it is more commonly called, specific gravity.

It has been recognised nevertheless that, considered as a series, the most remarkable correlative attribute of the elements is their specific gravity. The atomic volume—atomic weight curve of Lothar Meyer (1) shows us that the atomic volume of the element is a periodic function of the atomic weight, but shows us very little relative to quantitative considerations of the density of the elements. In fact, if we try to find any exact mathematical relation of the density of the ele-

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(1) "*Outlines of Theoretical Chemistry,*" 1899.

ments from the periodic table of Mendeléeff, we will find it impossible to draw any such conclusion. The periodic table, being merely qualitative in character, and *based upon the maximum valency being* eight, does not give us exact conclusions, for elements show different valencies according to the conditions and the elements with which they combine—especially with oxygen. In *other words, valency is a* variable quantity.

E. Bradbury (2) *attempted to group the* elements according to their specific gravity in only a rough way, but he made no quantitative classification—merely showing a few relationships in atomic weights which exist between analogous elements classed according to specific gravity.

G. Woodiwiss (3) *tried to show* some relation between atomic weight, valency and specific gravity. He states that the specific gravity of non-metallic elements possessing *the same valency are proportional to their atomic weights, but groups with* different valencies are connected by this relation:—Specific gravity divided by square root of valency is proportional to atomic weight. Further that inert elements *of the argon group come under this* so-called law by assigning to them the valency 0.5. The valencies given are different than those which have been found by experiment, thus Cu and Ag are given *as seven, Zn is six Co is eight, etc. Thus* his relationship is not based on experimental facts in the case, and devises nothing new than was practically brought forth by Borchers (4), who finds that if the equivalent *volumes (atomic volume divided by* maximum valency) are employed instead of the atomic volumes, the atomic volume —atomic weight curve of Lothar Meyer—is more regular and the relations stand out *more clearly. Borchers tries to fill in the* gaps of the curve, and ventures to predict the atomic weights and densities of unknown elements.

Samuel Smiles (5), in his discussion of volume relations, says that Schroder's (6) work on atomic volume seems to be of fundamental character, and although it was *impossible to find* any definite *physical* interpretations for it, it seems to contain the germs of comprehensive law governing volume and chemical composition, and that we have some indication of an *intimate connection between volume and* valency. Schroder's work shows that the atomic volume, although variable, is always a simple multiple of a certain volume unit called the "stere." The so-called "stere" *is not the same for all elements,* but it varies within *quite narrow limits.* Further, when two elements are combined, one of them assumes the volume unit of the other; the stere of one of the elements seems to dominate the volume of the compound.

It will thus be seen from the above summary of the most important and fundamental work on density, that we do not at present have any clear quantitative connection with atomic weight and valency ohter than that of a general idea that in compounds the volumes of equivalents of different elements are approximately equal, or stand in some simple ratio to one another, with perhaps some indication of an intimate connection between volume and valency.

The purpose of this study of the density of the elements was first to correlate in a quantitative way the density of the elements themselves. The next step was the relation with specific heat, since it was noted that, in general, as the density of the elements was increased the specific heat was decreased. The correlation of specific heat, density, and valency was attempted, likewise these relations with atomic number of the elements. The results obtained in these classifications, where maximum valency toward oxygen was used, are given under the experimental part of this paper. The known maximum valency toward oxygen of some of the elements cannot be used to obtain con-

(2) *Chemical News*, 1906, XCIV., 157-8, 245.

(3) *Chemical News*, 1908, XCVII., 122-4. 265 (1908).

(4) *Die Beziehungen zwischen aquivalent Volumen und Atomgewicht, Halle,* 1904.

(5) "*The Relations between Chemical Constitution and Some Physical Properties," Ramsay Series of Physical Chemistry.*

(6) *Pogg Ann.*, 1840, LVI., 553; *Wied. Ann.*, 1898 IV., 435; 1880, XI., 997; 1881, XIV., 656; *Ber.*, 1877, X., 848, 1871.

stant results, and the theory is advanced that we have not as yet found by experiment this maximum valency toward oxygen for a few of the elements. From the scheme proposed, this maximum valency toward oxygen can be ascertained.

Experimental Study.

If the density of the elements are arranged in their natural order and are grouped in fives, we find the following mathematical relationship among the elements in their solid state. The gases are calculated to the average density as they would be found in a solid chemical compound, if such compound were made. The average temperature at which the densities were taken was about 25° C.

Table I.

Density of the Elements.

0.1	0.6	1.1	1.6	2.1	2.6	3.1	4.1	5.1	6.1	6.6	7.1	8.1	9.1
—	Li.	Dy.	Ca.	S(Nat)	B.	Br.	Zr.	—	Nb.	Ce.	Zn.	Rd.	Mo.
	0.59	1.1	1.57	2.07	2.68	3.14	4.15		6.1	6.63	7.1		9.0
0.2	0.7	1.2	1.7	2.2	2.7	3.3	4.3	5.3	6.2	6.7	7.3	8.3	9.3
H.	Kr.	Cl.	Mg.	P (Red)	Al.	Ho.	Se.	Ge.	La.	Sb.	In.	Co.	Tm I
0.21	0.73	1.2	1.74	2.2	2.7		4.28	5.46	6.2	6.71	7.28	8.5	
0.3	0.8	1.3	1.8	2.3	2.8	3.5	4.5	5.5	6.3	6.8	7.5	8.5	9.5
He	K.	Gd.	O.	Si.	N.	C.	Ti.	V.	Te.	Cr.	Mn.	Cd.	Tm II
0.31	0.86	1.31	1.79	2.3	2.8	3.51	4.5	5.5	6.25	6.8	7.37	8.64	
0.4	0.9	1.4	1.9	2.4	2.9	3.7	4.7	5.7	6.4	6.9	7.7	8.7	9.7
Ne.	Xe.	F.	Cs.	Eu.	Tb.	Ba.	Er.	As.	Pr.	Nd.	Sm.	Ni.	Yb.
0.42	0.90	1.4	1.88			3.75	4.77	5.72	6.47	6.96	7.7	8.7	
0.5	1.0	1.5	2.0	2.5	3.0	3.9	4.9	5.9	6.5	7.0	7.9	8.9	9.9
A.	Na.	Rb.	Be.	Sr.	Sc.	Y.	L.	Ga.	Sn.	(R'm'c)	Fe.	Cu.	Bi.
0.55	0.97	1.52	1.93	2.5	3.0	3.8	4.94	5.92	6.55	Lu.	7.86	8.93	9.8
			Diff. 0.1				0.2		0.1		0.2		

10.1	11.1	12.1	13.1	19.1
E. Nd	Th.	Rh.	Act.	W.
	11.0	12.1		19.1
10.3	11.3	12.3	13.3	19.3
E. 1.	Pb.	Ru.	—	Au.
	11.34	12.26		19.3
10.5	11.5	12.5	13.5	21.5
Ag.	Pd.	E. Cs.	Hg.	Pt.
10.5	11.5		13.55	21.4
10.7	11.7	12.7	16.7	22.7
E.Mn.	Ux.	Po.	Ta.	Ir.
I.			16.6	22.4
10.9	11.9	12.9	18.9	22.9
E.Mn.	Tl.	Nt.	U.	Os.
	11.85		18.7	22.48
	0.2			

From the above mathematical conception of the density of the elements, it is quite possible that the first thirty elements, arranged according to their increasing density, differ by a gradual increase of one-tenth; the next fifteen by a gradual increase of two-tenths; the next ten elements by one-tenth; the next thirty by two-tenths; and the last ten elements seem to have the following relation: the first three increasing in density by two-tenths the fourth element increasing from the third of this group by three and two-tenths the fifth element from the fourth by two and two-tenths, the sixth element from the fifth by two and two-tenths, the seventh from the sixth by two-tenths, the eighth from the seventh by two and two-tenths, the ninth from the eighth by one and two-tenths, and the tenth from the ninth by an increase of two-tenths.

Having classified the density of the elements themselves, the next step is to find in an indirect way the relation of density to the chemical characteristics of the elements, if such exists. After considerable experimentation with the known chemical and physical constants of the elements, it was decided to use constants which could be determined for practically all known elements. These constants are the Atomic Numbers of Moseley and the Specific Heats at 100° C. of the elements. The particular significance of Moseley's Atomic Numbers is that the Atomic Numbers represent the number of unit positive charges of electricity in the nucleus of the atom of each element. Again the Atomic Numbers place the elements in their correct chemical order, leaving a place for the rare earths which have no satisfactory place in the Periodic System of classification. The significance of the Specific Heats of the elements is Dulong and Petit's well-known law, connecting specific heat and atomic weight, this law becoming quite constant when the specific heat is taken at 100° C. of the element, the constant being approximately 9.5 for the rare gases.

Now if the elements are arranged according to their maximum valence toward oxygen, we find the elements classed into *groups, each group having characteristics* similar in their chemical properties. The relation of these chemical properties is mathematically expressed by the following formula, which connects density, specific *heat at* 100° C. *of the element*, atomic number, and valency:—(Density x Specific Heat at 100° C. of the Element x Atomic Number), divided by the Maximum Valency toward Oxygen. The *elements group themselves into fives as in* the classification of density, but different groupings are observed as regards the elements themselves. The following table gives the following concept as regards such *relation* :—

TABLE II.

Relation of Density, Specific Heat at 100° *C. of the Element, Atomic Number,* Maxi*mum* Valency *toward* Oxygen, and Average Chemical Characteristics.

Group No. of Element (Maximum Valency toward Oxygen).	Figures in these columns represent the following formula:—(Density x Specific Heat x Atomic Number) divided by the Group No. of the Element.				
0.	He.	Ne.	A.	Kr.	X.
	1.5	2.0	2.5	3.0	3.5
1.	He.	O.	F.	Cl.	Br.
	1.5	2.0	2.5	3.0	3.5
1.	Li.	K.	Na.	Rb.	Cs.
	1.5	2.0	2.5	3.0	3.5
2.	Ca.	Mg.	Be.	Sr.	Ba.
	1.5	2.0	2.5	3.0	3.5
3.	Gd.	B.	Al.	Sc.	Y.
	1.5	2.0	2.5	3.0	3.5
3.	Er.	La.	Ga.	Pr.	Nd.
	4.0	4.5	5.0	5.5	6.0
3.	In.	Sm.	Co.	Fe.	Ni.
	6.5	7.0	7.5	8.0	8.5
4.	C.	Si.	Ti.	Zr.	Ge.
	1.5	2.0	2.5	3.0	3.5
4.	Ce.	Zn.	Rd.	Cd.	Cu.
	4.0	4.5	5.0	5.5	6.0
4.	Th.	Pb.	Pd.	Rh.	Hg.
	6.5	7.0	7.5	8.0	8.5
5.	N.	P.	V.	As.	Sb.
	1.5	2.0	2.5	3.0	3.5
5.	Sn.	Nb.	Bi.	Ag.	Tl.
	4.0	4.5	5.0	5.5	6.0
5.	Yb.	Lu.	—	Ho.	Tb.
	6.5	7.0	7.5	8.0	8.5
6.	S.	Se.	Te.	Cr.	—
	1.5	2.0	2.5	3.0	3.5
6.	Eu.	Dy.	Po.	Nt.	Act.
	4.0	4.5	5.0	5.5	6.0
6.	Ux.	E.Cs.	Ta.	W.	U.
	6.5	7.0	7.5	8.0	8.5
7.	Tm.I.	Tm.II.	I.	Mn.	Mo.
	1.5	2.0	2.5	3.0	3.5
8.	Ru.	E.Nd.	E.I.	E.Mn.I.	E.Mn.
	4.0	4.5	5.0	5.5	6.0
8.	Pt.	Ir.	Os.	Au.	—
	6.5	7.0	7.5	8.0	8.5

The *mathematical conception* given in Table II. was derived from averages, for it was found that we have a mathematical periodic relation. The first twenty elements containing the group numbers of 0, 1, and 2, *and the first five members* of groups 3, 4, 5, 6, and 7 in rotation gave the following formula numbers: 1.3, 1.8, 2.5, 3.1, and 3.7. The second five members of group numbers 3, 4, 5, 6, and the first five members of *group* 8 gave the following formula numbers: 4.1, 4.9, 5.3, 5.7 and 6.0 as the averages. The third five members of group numbers 3, 4, 5, 6, and

the second five members of group 6 gave the following formula numbers: 6.6, 7.0, 7.5, 7.9, and 8.6. From these formula numbers, it was therefore easy to construct a ratio of formula numbers that would be reasonable to expect working from the last members of the higher groups backwards, since it is easier to obtain the specific gravity and especially the specific heat of the heavier metals more exact. The mathematical conception, therefore, was as given in Table II., namely: 1.5, 2.0, 2.5, 3.0, and 3.5 for the first series; the second series being 4.0, 4.5, 5.0, 5.5, and 6.0; and the third series being 6.5, 7.0, 7.5, 8.0, and 8.5. It is seen that the members of each group number differ by exactly five-tenths. The differences of the average group formula numbers and the exact concept as given in Table II. must be atributed to the temperature at which the specific heat was taken; it was therefore thought best to construct a table of specific heats from he exact relations found out by the indirect method of averages rom the formula giving the relation between the density, specific heat, atomic number and group number of the elements.

(To be continued.)

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Section I.—Physiology.

THE EFFICIENCY OF MAN AND THE FACTORS WHICH INFLUENCE IT.

Address by Professor E. P. Cathcart, M.D., D.Sc., F.R.S., President of the Section.

The subject of my address—the efficiency of the human organism and the factors which influence this efficiency—is, in my opinion, one of the most important problems of the present day. It is a problem which cannot, however, be considered only from its physiological aspect if it is to receive adequate consideration; its implications are much wider, reaching right down to the very basis of our daily lives. As I a mno expert in industry or economics, I shall confine my attention as far as possible to the problem from the physiological side, and leave to others the sociological application.

The term "efficiency" has become a mere catchword, bandied about by people who have not the faintest idea of what the word connotes. Practically it has come to mean, to the average man in the street, the mythical improvement which is to be anticipated from some change in workshop or office organisation—a bigger and better result at a smaller cost. The word has a very definite meaning in engineering science, and this meaning has been transferred from the inanimate machine to the living organism. In the case of the engine the problem is relatively simple, as the number of interfering factors is not great, but the solution of the problem in the case of the organism is beset with many difficulties, as the interfering factors are numerous and varied. Two types of efficiency are spoken of in connection with the animal body. One type is the mechanical efficiency in the engineering sense, *i.e.*, the ratio which exists between the heat equivalent of the external muscle work done and the energy output of the subject during the performance of the work in question. This is a problem which has attracted many workers, and there seems to be a general concensus of opinion that the efficiency of man in the performance of external work is about 20 per cent. gross and 25 per cent. net. (*Gross* efficiency is obtained by dividing the actual heat equivalent of the external work done by the total output of energy of the man during the time occupied in the performance of the external work, and *net* efficiency is obtained by dividing the heat equivalent of the external muscle work done by the actual increase in the energy output of the subject over the basal energy output ruring the performance of the work in question.) As A. V. Hill has pointed out, this striking unanimity is in all probability due to the fact that the maximum value of efficiency remains more or less constant over a fairly wide variation in the mode of the performance of the work. The work referred to here is wholly concerned with muscle activity. The other type of efficiency is that which is called industrial or productive efficiency, where the capacity of the individual to perform effective work is dealt with, judging the capacity of the individual by, for example, his output in unit time. So far as the worker himself is concerned, the whole object in industrial efficiency is undoubtedly to get the greatest output with the minimum of effort. The determination of the mechanical efficiency is fairly readily carried out, but it is very difficult to get an

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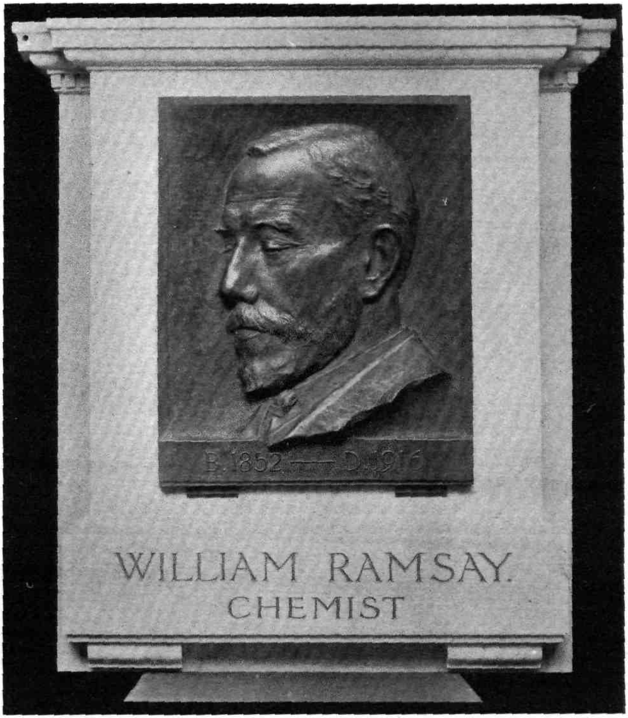
November 10th, 1922.



accurate gauge of the industrial efficiency. At bottom they are closely related, and both are physiological problems.

The leaders of industry have not been slow to accept and utilise the gains of science in the realm of inanimate things, but they have been slow to recognise the fact that there is a science of physiology which deals with the man who controls the productive machinery. New inventions may completely revolutionise shop equipment, good machines may be replaced by better, and better by still better, but man remains almost as immutable as the ages. Physiological evolution is infinitely slow. As Lee puts it, "Try as we will, we cannot get away from the fact that so long as machines need men, physiological laws must be reckoned with as a factor in industrialism." Butler, in "Erewhon," satirised in his inimitable way this very problem of the industrial world as follows: "So that even now the machines will only serve on condition of being served, and that upon their own terms; the moment their terms are not complied with they jib, and either smash both themselves and all whom they can reach, or turn churlish and refuse to work at all. How many men at this hour are living in a state of bondage to the machines? How many spend their whole lives, from the cradle to the grave, in tending them night and day? Is it not plain that the machines are gaining ground upon us, when we reflect on the increasing number of those who are bound down to them as slaves and of those who devote their whole souls to the advancement of the mechanical kingdom? . . May not man himself become a sort of parasite upon the machines? An affectionate machine-tickling aphid?"

It is a clever picture, and if one looks back on the rise of industrialism it is not so very far-fetched. It is but a little more than a hundred years since this country was industrialised, and we are still reaping the aftermath of the terrible conditions which then reigned, when the great centres of industry were swamped with country dwellers who poured into the towns in the race for wealth. Few realise the hopelessly unphysiological conditions which developed in the methods of work, the hours and conditions of work, the housing. Many talk now of the hardship of the eight hours' day under conditions which are relatively civilised, where the place of labour and the methods and machinery used are supervised by skilled and honest Home Office inspectors, where child labour is firmly controlled, and where practically all abuses are checked. The following citation from Robert Owen, that "shrewd, gullible, high-minded, wrong-headed, illustrious and preposterous father of Socialism and Co-operation," as Lytton Strachey calls him, gives a good idea of the conditions ruling in the early years of last century in one of our staple industries. "In the manufacturing districts it is common for parents to send their children of both sexes at seven or eight years of age, in winter as well as summer, at six o'clock in the morning sometimes, of course, in the dark, and occasionally amidst frost and snow, to enter the manufactories which are often heated to a high temperature, and contain an atmosphere far from being the most favourable to human life, and in which all those employed in them very frequently continue until twelve o'clock at noon, when an hour is allowed for dinner, after which they return to remain, in a majority of cases, till eight o'clock at night." Six till eight, with a break of one hour: a fourteen hours' day, and fifteen was not unknown. Owen, in the article from which I have quoted, was petitioning Parliament, asking what? That a twelve hours' day be instituted, to include one and a-half hours for meals, and that no child should be employed until the age of ten was reached. He pointed out in the course of the article that the results from the manufacturers' point of view would be better with a twelve hours' day (*i.e.*, that the industrial efficiency, in modern words, would be improved).

Yet we wonder that the offspring of stock descended from workers under these conditions, which certainly improved as the century advanced but were far from ideal, gave the high yield of C3 lads recorded in the National Service Report. We might have been prepared for the disclosure, as the pre-war records of countries with conscription showed that the number of rejections for the Army of town and factory workers was far in excess of those for men drawn fro mcountry districts. But evidence of the state of the national physique is not confined to these war figures. Sir George Newman, in his valuable and interesting Report on Preventive Medicine, has drawn attention to the enormous amount of time which is annually lost through sickness. The minimum average

amounted to 14,295,724 weeks (or a period of upwards of 270,000 years) of sickness *per annum*, *and this figure did not include* absence from work due to maternity benefit, sanatorium treatment, or absence for less than four days per patient. This is the evidence of the National Health Insurance.

The design of the organism which has to stand the strain is not at fault. It is an organism which, in the language of the engineer, is *abundantly supplied with factors of safety*, and has an over-all high factor of safety. The body is not designed merely to perform the minimum amount of work or to stand the minimum strain; there is always a reserve. We have a circulatory system which is beautifully balanced to meet a strain, a system of vessels whose calibre can be increased or *diminished so that the blood may be* mobilised at the tissues or organs which require it, and a heart which has the capacity, provided it is normal and healthy, of responding to work, whose rate may be trebled in a few seconds when oxygen must be obtained and carbon dioxide got rid of. Not only can the amount of blood which is passed through the lungs during *hard work be increased some five times*, but the amount of oxygen taken in may rise ten times. Thus the subject studied by Benedict and myself had a normal consumpt of about 200 cc. oxygen per minute, and in one experiment he kept up an intake of nearly 2,000 cc. per minute for four hours and twenty-two minutes on end. Quite often the same subject used 2,700 *cc. to 3,000 cc. for ten minutes at a time*.

Again, at rest less than a third of the oxygen present in the blood is required, and *even in the very hardest work the arterial* blood is not depleted of its oxygen; it probably still contains more than a fourth. Curiously enough, the actual effectors, the muscles, do not of themselves seem to have a very high factor of safety. The structures, bones, and cartilage, to which they are attached, and which limit their action, and the amount of strain to which they can be exposed or subjected, have a very high factor of safety. A further protective mechanism for muscle is the perfect coordination between the groups of muscles, the elucidation of which problem we owe largely to our President, Sir Charles S. Sherrington. We have another reserve of first-class importance—viz., that when the strain on one group of muscles is becoming too severe, more and more groups of muscles are brought into action to help in meeting the strain, until in the end, if need be, practically the total musculature of the body is involved. And behind all this there are final factors of safety such as fatigue, which is a protective warning; *and finally, if the latter be not heeded*, collapse.

This perfect co-ordination of the different parts of the organism is required, because the human being is capable of intense muscular exertion for short periods. The intensity of the work is as a general rule inversely proportional to the length of time during which it must be carried out. The following table (Table I.) gives some idea of what is probably about the maximum effective muscular work per minute (modified from Blix):—

TABLE I.

Nature of Work.	Duration of Work.	Effective Muscular Work per min. Kilogrammètres	Calories.
Mountain climbing, moderate	Many hours	500	1.16
Mountain climbing, severe	1 to 2 hours	750—1,000	1.74—2.33
Mountain climbing, very severe	3.75 minutes	2,000	4.65
Treadmill	30 seconds	2,400—3,600	5.58—8.37
Running upstairs, 10 Kg. load	15 seconds	3,700	8.61
Running upstairs, no load	30 seconds	4,300	10.00
Running upstairs, no load	4 seconds	5,700—6,000	13.26—13.95

If, in the human organism, we were merely concerned with the co-ordinated action of a series of effectors, with the capacity of a certain group of muscles to perform a given amount of work, the solution of the problem would be relatively simple. But we are dealing with a living organism capable not only of doing work but of repairing the worn-out parts, as and when required. Further, we are dealing with an organism which varies not only in its capacity to perform work, but in its "will to work." We are dealing with a subtle organism which has a whole series of protective mechanisms at its command, an organism which can be fatigued and rendered useless, as a working unit, by an amount of work on a particular day which on another day it can perform with the utmost ease and without apparent fatigue. We are dealing with an organism which can and does perform real hard muscular work with vigour and joy, and yet, if the nature of the employment or the environment be distasteful, can be reduced to impotence by work capable of being done by a child.

Again, the efficiency of a man is not merely dependent on the amount of work which can be performed by his muscles; the circulatory, respiratory, and nervous systems are of equal importance, and all are intimately related. The muscles must receive an abundant supply of blood, not merely to bring nutriment but to remove waste; there must be an efficient exchange of gases in the lungs, the rate of the respiratory and cardiac movements must be adapted to the work in hand through the co-ordinating agency of the central nervous system. Not only so, but, if the man is to work with the minimum of waste energy, there must be proper co-ordination between the various groups of muscles. A man does not walk, for instance, by the aid of his leg muscles alone, his lumbar muscles are equally important. Further, it is not a mere question of autonomic reflex adjustment, important though this may be, for much of the work done the attention must also be invoked. Yet, in spite of the many and varied stresses and strains to which the organism is subjected in the course of life, as the result of the many factors of safety, unless the overloading is excessive, too frequent or too long continued, the organism, so long as it remains physiological, is practically unaffected by ordinary hard work.

If we turn now to the consideration of the factors which influence the efficiency, both in the mechanical and the industrial sense, we find that the main controlling factor is undoubtedly the condition known as fatigue. Fatigue is a word just as frequently used as efficiency, and yet it is almost impossible to give an accurate definition of the term. Generally speaking, it is to be regarded as the antithesis of efficiency. As Vernon put it, "By so much as fatigue is avoided or eliminated in industrial operations the efficiency of the worker is increased." Fatigue may be summarised as a diminished capacity for doing work. The question of the site at which fatigue is first manifested, whether it is a central or a peripheral phenomenon, whether it is a specific condition, or whether, as Crile maintains, there is no ultimate difference between the bloodless intangible causes of fatigue and exhaustion and the bloody tangible causes of "shock," lies without the scope of this address. One of the great difficulties in the solution of the question is that no one has as yet devised a method which permits of a quantitative determination of the degree of fatigue. Indeed, some workers, Muscio for example, have definitely stated that such a test is an impossibility.

(To be continued.)

MEETINGS OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, NOVEMBER 2, 1922.

Papers read:—

LORD RAYLEIGH, F.R.S.: *Polarization of the Light Scattered by Mercury Vapour near the Resonance Periodicity.*

G. P. THOMSON: *The Scattering of Hydrogen Positive Rays and the Existence of a Powerful Field of Force in the Hydrogen Molecule.* Communicated by Sir J. J. Thomson, F.R.S.

H. D. SMYTH: *A new Method for Studying Ionizing Potentials.* Communicated by Sir Ernest Rutherford, F.R.S.

I. BACKHURST: *Variation of the Intensity of Reflected X-radiation with the Temperature of the Crystal.* Communicated by Sir William Bragg, F.R.S.

S. DATTA: *The Absorption Spectrum of Potassium Vapour.* Communicated by Prof. A. Fowler, F.R.S.

K. R. RAMANATHAN: *The Molecular Scattering of Light in Vapours and in Liquids, and its Relation to the Opalescence observed in the Critical State.* Communicated by Dr. G. T. Walker, F.R.S.

THE OPTICAL SOCIETY.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, SOUTH KENSINGTON, S.W.7.

THE HISTORY OF THE PHOTOGRAPHIC LENS.

The third of the series of lectures dealing with the evolution and development of optical instruments will be delivered at the Imperial College, at 7.30 p.m., on Thursday, 9th November, 1922, by Dr. R. S. Clay.

Subject: *The history of the photographic lens.*

The lecture will be illustrated by a number of lenses of historic interest.

Discussion on *Spectacles and spectacle construction.*

PRELIMINARY NOTICE.

At a meeting of the Society to be held on the 30th November, 1922, a series of papers will be presented dealing with spectacles and spectacle construction. Fellows and members desiring to contribute to the discussion are invited to communicate with the librarian, Mr. J. H. Sutcliffe, O.B.E., Clifford's Inn Hall, E.C.4, or with the "Papers Secretary" at 50, Bedford Square, W.C.1.

F. F. S. BRYSON,
Joint Hon. Secretary.

MINERALOGICAL SOCIETY.

ANNIVERSARY MEETING, HELD ON TUESDAY, NOVEMBER 7, 1922.

Papers were read by:—

W. A. RICHARDSON: *The frequency-distribution of igneous rocks in relation to petrogenic theories.*

MISS NAGGS: *Crystallography of organic compounds.*

DR. G. T. PRIOR: *The meteoric iron of Karee Kloof, Cape Province, and the meteoric stone of Leeuwfontein, Pretoria, S. Africa.*

THE SOCIETY OF DYERS AND COLOURISTS.

MANCHESTER SECTION.

The second meeting of the Manchester Section of the Society of Dyers and Colourists for the session 1922-1923, was held at the College of Technology, Manchester, on Friday, October 27th.

Prof. Knecht presided.

"*A Hydroxy-stearic acid and some of its derivatives*, by L. G. RADCLIFFE, M.Sc.TECH., F.I.C., and W. GIBSON, M.Sc.TECH.

This paper was a continuation of one published in March, 1920, in the Journal of the Society of Dyers and Colourists, under the title, "The action of Nitric Acid on Saponifiable Oils," by one of the authors and C. Polychronis.

In this paper it was stated that upon the experiments recorded therein it appears that the action of nitric acid on various oils varies according to the nature of the fatty acids which enter into their composition. It was pointed out that with the saturated fatty acids there was little action in the cold with even 99 per cent. fuming nitric acid, but that the hot nitric acid caused oxidation, and in the case of stearic acid, Isonitro-stearic acid was found among the other oxidation products. In the case of the unsaturated acids such as Oleic acid, ordinary nitric acid reacts in the cold, but the reaction takes place very slowly, whereas fuming nitric acid reacts much more vigorously, and even at quite low temperatures yields a nitrated product.

The paper referred to some former work on the sulphonation of oleic acid, which resulted in the formation of hydroxy-stearic acid, and then went on to detail experiments having for their object the determination of the chemical composition of various products formed by the action of nitric acid on pure hydroxy-stearic acid. The earlier part of this work was the preparation of hydroxy-stearic acid itself and a number of characteristic derivatives.

The starting point for the hydroxy-stearic acid was an oleic acid of about 93 per cent. strength, which by treatment with sulphuric acid, as described in a previous paper, gave rise, after the product of the first reaction was treated with water, to the hydroxy-stearic acid melting at 85° C. The composition and properties of this hydroxy acid corresponded to those recorded by previous workers. From this acid the authors have prepared, for the first time, the methyl ester of hydroxy-stearic acid in the form of white flakes, melting at 46° C. Further, the ethyl ester

elting at 48.5°, and an acetyl derivative, elting at 32° C., were made, but all attempts to benzoylate the acid failed to yield a derivative in a state fit for analysis. A study of the interaction of Bromostearic acid and silver nitrite was described, having for its object the preparation of true nitro compounds of stearic acid. Many experiments were detailed, with references to the work done by other investigators, and as a conclusion it was stated that no such nitro acid could be obtained, and a similar failure took place when silver nitrate was used. In every case the reaction proved to be not a simple double decomposition, and the products did not contain nitrogen.

The views previously set forth by Senter were confirmed, and only the more or less impure alpha-hydroxy-stearic acid resulted.

Later, the action of nitric acid on hydroxy-stearic acid was dealt with, and a fine yellow crystalline compound was obtained, having a melting point of 82° C. This compound was an acid, and from it a number of derivatives were prepared and analysed, but the authors had obtained contradictory results which at the moment cannot be so far reconciled as to enable them to construct a constitutional formula for this yellow compound. One thing, however, was quite certain, that the substance did not contain nitrogen, and in this connection some interesting experiments were described, showing how the ordinary method of analysis was liable to show the presence of nitrogen when in reality no nitrogen was in the compound. In this connection reference was made to a paper published by the United States Bureau of Mines on the determination of nitrogen in coal by Fieldner and Taylor, who showed that both fine and coarse copper oxide, when partly reduced and reoxidised in air retain nitrogen which is not completely removed at room temperature by evacuation and replacement with carbon dioxide. Such an oxide gave considerable quantities of nitrogen when heated alone, as in the Dumas method for the determination of nitrogen.

It was concluded that the errors which had occurred were explained by this research, and the absence of nitrogen in the yellow compound was further confirmed by the usual qualitative tests. The yellow crystals were studied in some detail, and prove to have a molecular weight, by the Landsberger-Walker-Lumsden method, of the order of 276, while chemical methods based on the supposition that the acid was monobasic gave quite different molecular weights. Other usual methods gave such varying results that no definite conclusions could be come to, though from the analysis of various salts a molecular weight of 291 appears to represent the acid. The esters, such as the methyl and ethyl, were made and described, but it was explained that as one of the authors was obliged to discontinue the work it has been presented in this unfinished state.

The authors conveyed their thanks to the Society of Dyers and Colourists, from whom a monetary grant had been made which had rendered the work possible.

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

PASS LIST—OCTOBER EXAMINATIONS, 1922.

The following candidates have passed the examination of the Associateship in General Chemistry:—

Chignell, Guy, B.Sc. (Lond.), University College, Southampton; French, Herbert, Heriot-Watt College, Edinburgh Wild, Francis Eric, B.Sc. (Birm.), Birmingham University; Young, Edward Bernard, B.Sc. (Lond.), East London College.

In Branch (d) Organic Chemistry (under regulations in force prior to March, 1920):

Baguley, Noel Gregory, University College, Nottingham; Cole, Frederic, University College, Nottingham.

GENERAL NOTES.

MINISTRY OF AGRICULTURE AND FISHERIES.

AGRICULTURAL EDUCATION IN ENGLAND AND WALES.

The Ministry makes grants in aid of the higher agricultural education provided at University Departments of Agriculture and Agricultural Colleges in England and Wales.

In addition, most of the counties of England and Wales provide agricultural education of a less advanced character, either through a permanent staff of instructors or through instructors attached to one of the Colleges referred to above. In many cases both systems are adopted.

The Ministry makes grants in respect of this work.

Briefly, the agricultural education now available consists of courses at various Colleges extending over two or more years and leading up to a degree or diploma; shorter courses at the same institutions; courses varying from a few weeks to a year at farm schools and similar institutions; courses of ten days or a fortnight in dairying at migratory dairy schools which visit a number of different centres each season; and courses of day or evening lectures, accompanied in many cases by practical instruction in agriculture, poultry-keeping, bee-keeping, farriery, horticulture and manual processes. Most County Councils offer scholarships, tenable at agricultural institutions or courses, to students resident in the county.

A number of counties carry out field experiments or demonstrations, and have fruit-growing stations, demonstration gardens or trial allotments.

It is not possible within the limits of this leaflet to give particulars of the activities of each county, but a short acount of the work of each Collegiate Institution and Farm Institute is given below. *Persons wishing to obtain further particulars should apply to the Secretary or Principal of the Collegiate Institution in question, or, in respect of Farm Institute or County work, to the Education Secretary or Agricultural Organiser at the County Council Offices.*

Before taking an institutional course it is very desirable—and in some cases an essential requirement for admission—that the student should have had some practical experience of farm work. Students who have not been brought up on the land are, therefore, strongly advised to spend at least a year on a well-managed private farm where they would have an opportunity of familiarising themselves with the routine seasonal operations. If a suitable farm for the purpose cannot be found by private enquiry it might be well to consult the advertisements or farm pupils which appear from time to time in the leading agricultural papers; or application might be made to one of the County Agricultural Organisers, who may be able to recommend a farm where such facilities are offered.

DEPARTMENT OF OVERSEAS TRADE.

EGYPT.

Tenders Invited: Wood Naphtha and Tierol.

The Egyptian Customs Administration invite tenders for the supply of the following:—

130,000 kilos of wood naphtha (wood spirit).

5,000 kilos of tierol

for denaturing ethyl alcohol.

Sealed tenders addressed to the Director-General of Customs, will be accepted at the Office of the Chief Inspector of the Customs Administration, Alexandria, up to noon on the 6th January, 1923.

A copy of the specification for each of the above mentioned commodities may be seen by United Kingdom firms on application to the Department of Overseas Trade (Room 53), 35, Old Queen Street, London, S.W.1.

Local representation is essential, and the Department will be pleased to suggest the names of agents who are prepared to act on behalf of United Kingdom firms not already represented. (Reference 9321/FE/CP).

NOTICES OF BOOKS.

The Nitrogen Industry, by J. R. PARTINGTON, M.B.E., D.Sc., and L. H. PARKER, M.A., D.Sc., F.I.C. Pp. XV. + 336 + 19 plates. London: Constable & Co., Ltd., Orange St., Leicester Square, W.C. 1922. Price 21s. net.

It is now some years since the late Sir William Crookes endeavoured to draw attention to the important question of the future supplies of nitrogenous fertilisers in his book, *The Wheat Problem*.

The authors of the present volume again press forward an urgent claim for the careful consideration of this matter by those in authority.

In the preface they draw attention to the dangers which attend a policy of dependance upon foreign supplies of nitrate, which are so necessary for agricultural purposes, and the manufacture of dyes and explosives.

The fixation of atmospheric nitrogen has become an imperative necessity, and the matter needs to be pursued until the most successful conditions and results have been attained.

The various processes of fixation are described in an interesting and informative way. Whilst being quite sound and scientific, the book is suitable for non-scientific

readers whose interest in this subject is most desirable.

Part I. deals with nitrogen products and Chile nitre. In Part II. the manufacture of ammonium sulphate from the ammonia of the gas-works is described. Part III. is concerned with the fixation processes, and includes an account of the methods for making synthetic ammonia, cyanamide, the arc processes, and lastly (perhaps most important of all) the oxidation of ammonia.

The subject is treated in a very practical manner throughout, and valuable technical and statistical information is presented in a convenient and striking form. The illustrations are also very good.

The book should be read not only by chemists, but should be brought to the notice of the educated and intelligent sections of the general public. To this end, chemists should endeavour to see it placed on the shelves of as many libraries as possible. J.G.F.D.

The Riddle of the Rhine, by MAJOR LEFEBURE, published by W. Collins & Co., Ltd., contains the following interesting foreword.

BY MARSHAL FOCH.

(*Translation*).

By the year 1918 great strides had been made in the development and use of chemical warfare by the Allied armies. Germany, by means of her pre-war chemical organisations had been able to develop rapidly the large scale manufacture of chemical products used on the front. The same factor was largely responsible for her great progress in this new form of warfare. The Allies, in self-defence, were compelled to investigate the new method of making war, and to organise huge factories to produce the required chemical munitions. Only by this means, and then with great delay, were they able to meet the growing needs of their armies.

The carrying power of the aeroplane is increasing. Improvements are made almost daily, enabling greater and greater weights to be carried. These developments introduce an entirely new method for the large scale military use of poison gas. By the use of bombs, which are becoming increasingly efficient and of greater capacity, not only have armies become more vulnerable, but the centres of population situated in the rear, and whole regions inhabited by civilians will be threatened.

Chemical warfare thus acquires the power to produce more terrible effects over much larger areas.

In addition, it is an unchallengeable fact that these developments can materialise most rapidly and effectively in Germany. This country, devoted in times of peace to the large scale manufacture of chemicals, can, by a simple modification in the processes of the industry, transform its peace products into those of war.

But Germany, deprived partially at least of its former armament and means of making war, of its innumerable carefully trained soldiers, well-organised and strongly armed, may well be tempted to develop the new methods of attach provided by chemical warfare.

If, then, we wish to avoid disastrous surprises, chemical warfare must necessarily enter into our forecast of the future, and our preparations for it.

Major Lefebure's book gives a clear idea of such possibilities as they exist to-day in Germany. It reveals the menace of these dangers. All those who have the interests of their country at heart will regard the book as a warning, and as a source of information of the first importance. They will give serious thought to their national position in view of the changes in armament, the present forms of which, through industrial progress, are daily becoming obsolete.

This is a dual note of warning, for, in sounding it I have by my side my good friend, Field-Marshal Sir Henry Wilson. This is indeed in keeping with the past, a practice forged by the intercourse of many years. In another common effort towards the maintenance of peace, we issue this warning for the future.

This, then, is our joint advice—read Major Lefebure's book. F. FOCH.

CUPRAMMONIUM SULPHATE.

By Geoffrey N. Ridley.

Cuprammonium sulphate is an interesting compound from the point of view of the peculiar attachment of the ammonia. Its formula is $Cu(NH_3)_4SO_4$; this article chiefly concerns the four molecules of ammonia.

That the ammonia is connected with the copper sulphate cannot be denied, but a true double sulphate is not formed. This can be inferred from the weak nature of the ammonia attachment. Thus a few drops of dilute mineral acid added to the blue solution are quite sufficient to destroy the cuprammonium sulphate, by extracting the ammonia to form a true ammonium salt. That such an action takes place is without doubt, for ammonia gas ceases to be evolved when the liquid is heated after treatment. Furthermore, the addition of acid produces a series of changes identical to those created in the preparation of the cuprammonium sulphate, but in the reverse order. Thus the light blue precipitate is first thrown down (the fine blue colouration being removed at the same time), which readily dissolves, leaving a pale blue liquid. If this solution containing the ammonium salt is boiled with caustic soda, ammonia is easily detected.

The effect of boiling the solution of cuprammonium sulphate is to drive off ammonia, by degrees, and at the same time cause a deposit of cuprous oxide to be formed, which becomes converted into black cupric oxide. A little heat applied to the solid compound drives off ammonia rapidly, leaving a greenish blue residue of copper sulphate.

The predominant observation from all these tests is the weakness of the connection by which the ammonia is attached to the copper sulphate. True, ammonium salts are comparatively unstable and easily dissociated, but if the ammonia in the cuprammonium sulphate is attached in the normal way, *i.e.*, ammonium sulphate, dilute sulphuric acid should have no effect on it. But it has been found that the addition of acid destroys the cuprammonium compound entirely. It is therefore supposed that the ammonia is not combined directly with the acid radicle. The ammonia can only be connected with the sulphate through the copper which it probably attacks when the metal is in the form of the hydroxide. An unstable aggregate of copper and ammonia is produced which is most conveniently called cuprammonium. In the light of experimental results, this seems to be the only satisfactory way of accounting for the behaviour of the ammonia when associated with copper sulphate.

Similar experiments with the nitrate of cuprammonium yield similar results.

Both the sulphate and the nitrate are crystalline, the sulphate crystallising in long, dark blue prismatic (?) forms.

New Patents.

This list is specially compiled for the *Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, *from whom* all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

27305—Barnard, C. M.—Process for manufacture of benzidine. Oct. 9.

27828—Hovies, F.—Process for manufacture of lead arsenate. Oct. 13.

27560—Kammermann, G.—Apparatus for extraction of oils and greases from vegetable substances. Oct. 11.

27826—McDogall, I.—Process for obtaining alkaloids or their salts. Oct. 13.

27608—*Metals Production, Ltd.—Recovery of lead* from lead sulphate. Oct. 11.

Specifications Published this Week.

186457—Fierz, Dr. H. E.—Apparatus for the manufacture and production of nickel from nickel-carbonyl.

186458—Fierz, Dr. H. E.—Manufacture and production of *metallic nickel from* nickel-carbonyl and apparatus thereof.

186517—British Dyestuffs Corporation.—Manufacture of basic dyestuffs possessing affinity for unmordanted vegetables fibres.

186515—British Dyestuffs Corporation.—Manufacture of *1-4-naphthol sulphonic* acid.

Abstract Published this Week.

Delivering Definite Volumes of Liquids.—Patent No. 184826.—A useful fitting for laboratories is an apparatus for delivering definite volumes of liquids into test tubes, invented by Mr. E. E. Glynn, of Thompson Yates Laboratories, The University, Liverpool.

The apparatus comprises a battery of cylinders provided with nozzles and plungers connected by universal joints to means for depressing the plungers through definite distances. In one form the plungers are connected to a bar adapted to be *moved by nuts and screws operated by worms* on a shaft of a crank. A spring pin carried by the crank engages successively a series of equi*distant holes in a fixed disc.* The *syringes deliver* into test tubes carried a stand provided with rollers engaging guide-rails, so that the several rows of tubes may be filled by sliding the stand under the nozzles. The cylinders may be filled from a trough having a longitudinal groove into which the nozzles dip, the trough being held in place by a spring-pin.

Messrs. Rayner & Co. will obtain printed copies of the published specifications, and forward on post free for the official price of 1s. each.

THE CHEMICAL NEWS,

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SOCIETY OF CHEMICAL INDUSTRY.

Birmingham and Midland Section.

A dinner in connection with the Birmingham and Midland Section of the Society of Chemical Industry was held on Saturday, Nov. 4, at the Queen's Hotel, Birmingham, Dr. E. B. Maxted presiding over a large and representative attendance of Midland chemists.

Mr. F. R. O'Shaughnessy, who was honorary secretary of the Section for 17 years, and who was largely responsible for its re-formation, recently retired, and to mark their appreciation of his services, the members presented him with a valuable laboratory microscope, complete with accessories, and an illuminated scroll signed by the members; and to Mrs. O'Shaughnessy, an opal and diamond cluster ring. These presents were formally handed over by Dr. E. F. Armstrong, the President of the Society. The toast of Mr. and Mrs. O'Shaughnessy was honoured on the motion of Mr. H. Silvester, who testified to the late hon. secretary's tact, efficiency and public spirit. Reviewing the history of chemical organisations in Birmingham, he pointed out that the Society of Chemical Industry was founded in 1880, and shortly afterwards the Birmingham Section was formed. It remained in existence, however, for only a short period. Sir William Tilden then started a new society, called the Birmingham Chemical and Metallurgical Club, which met at the White Horse Hotel, and after dinner discussed contributions on chemical subjects. Later, it removed to the Woodman Hotel, where light refreshments took the place of the dinner, and then Mr. O'Shaugnessy intervened. He pointed out the great disadvantage they were under in that publicity was not given to the discussions, and on his suggestion, the Birmingham and Midland Section of the Society of Chemical Industry was again formed. So that really, Mr. O'Shaughnessy was the cause of the downfall of the Birmingham Chemical and Metallurgical Club. That club left a memorial of its existence in a gift of £10 to the library of the Chemical Dept. of the Birmingham University, where the Midland Section of the Society now held their meetings. Professor P. F. Frankland, of the University, was the first President, and Mr. O'Shaughnessy the first hon. sec. Mr. Silvester pointed out that it would have been far easier to have started an entirely new society than to have created one from another organisation, but that was done, thanks largely to Mr. O'Shaughnessy; year after year he had secured a good programme of papers, which was no easy matter, having regard to the many other technical organisations, and during his period of office 175 papers were contributed to the Midland Section, and the bulk of them had appeared in the Journal of the Society. Mr. O'Shaughnessy had also organised the general meetings—in 1907 and 1917; and in addition arranged various meetings with other societies and visits to works.

Dr. Armstrong paid tribute to Mr. O'Shaughnessy's work, and to the splendid services rendered by the secretaries of local sections. The discoveries Mr. O'Shaughnessy had made had enriched chemical science, and had benefited the public; his hope was that the microscope would enable him to amplify his discoveries, particularly in relation to the scientific treatment of sewage, and help the world more than he had done.

Mr. O'Shaughnessy fittingly acknowledged the gifts, which his wife and himself would always highly value. He pleaded for the introduction of more of the social element into the doings of the Society.

Responding to the toast of the "Society of Chemical Industry," proposed by Mr. E. C. R. Marks (Mechanical Engineers' Institution, Birmingham Section), Dr. Armstrong, whose name was coupled with the toast, said what he desired to tell them was that the Society of Chemical Industry had a very definite policy. Their policy this year had been to put the chemical profession in a position they thought it ought to occupy—on a par with that of the lawyer, the doctor, and the engineer. The latter, who was perhaps more akin to the chemist, had learnt the necessary lesson: (1) of sticking together, and (2) the value of publicity. "We chemists have within the next few years," he said, "to make up our minds whether we are

going to rehabilitate ourselves as a profession, or whether we are content to remain in the wilderness, and I think it is my duty to go to the sections and preach this doctrine. We have to do all we can to enhance the status of the profession, and to cultivate professional etiquette." (Hear, hear.) He was particularly glad to hear Mr. O'Shaughnessy tell them that they must cultivate the human side. If they did not recognise their faults they could not get right. By all means let them, as chemists, do all they could by practice and research for the benefit of the chemical industry and of the world, but concurrently with those efforts let them be men of broad outlook, ideals, and ambitions, and cultivate the human side in themselves. That must be done if chemistry were to attain the position they desired it to reach. (Hear, hear.)

Professor Ling (Birmingham University) proposed the toast, "The Guests," and Mr. Smout (Birmingham Metallurgical Society) replied, pointing to the importance of chemistry in relation to metallurgy, and expressed the belief that the latter was coming back more to basic principles—to chemistry.

Dr. Maxted hoped the meeting would mark the beginning of a long series of annual dinners.

CHEMICAL AND PHYSICAL SOCIETY, UNIVERSITY COLLEGE, LONDON.

On Tuesday, Oct. 17th, at the first meeting of this session, Prof. J. C. Drummond, this year's President, chose as his subject, "Cod-liver Oil." At the outset, he mentioned that his choice of subject was due to a desire to set before the meeting a typical bio-chemical research which, as he showed later, extended from purely chemical to definitely biological aspects.

Cod-liver oil, he said, was a known and proved remedy of remote ages in Norway, and in China early records show its use in an attempt to combat eye disease in children, with apparent success. Coming to modern times, the growth of chemical and medical knowledge began to be applied to the discovery of the therapeutic agent in cod-liver oil. Three theories existed to account for this and similar cases (a) the Iodine theory, where the cause was ascribed to Iodine, probably in combination; (b) the Amine theory, introducing the known merits of amino-acids; (c) the Unsaturated Acids theory, which are useful by reason of their easy digestibility.

The great enlightening discovery was that of Vitamines in 1912, by Hopkins, and this was followed by the work of American investigators on certain animal oils.

The lecturer emphasised the extremely minute amounts necessary to restore normal growth in an animal suffering from rickets, 2 mgms. of cod-liver oil being sufficient, and of this, 98 per cent. is known to be glycerides of no anti-rachitic value.

Coming to the reasons for its efficacy, Dr. Drummond described his work with the expedition to Norway, sent by the British Medical Council to establish the reason why the crude oil of 30 years ago is richer in Fat-Soluble A than the modern product. With the aid of lantern slides, he showed the historic method by crude fermentation of cod-liver in open vats, yielding the red-brown oil familiar to older generations. While this method is nearly extinct, the modern process of steam heating, either by direct or indirect application, is by no means well conducted from an hygienic point of view, only one factory being run on any scientific lines.

The party's examination brought out the astonishing fact that the fermentation by the old or new process, and the simple freezing-out methods of refining the crude oil showed no loss of vitamine products, but that there was a seasonal variation in quality. It was, therefore, decided to investigate the life-history of the cod from the point of view of vitamine conservation. The results were remarkable.

Along the coast of Norway runs a northward stream, ending in the Behring Sea, and it was found that the cod came south against this stream in the spring to find suitable spawning grounds. The fish prefer shallow sand-banks, and such places are rare. There are two off the coast of Norway, the Romsdal and Lofoten Islands banks, and here the cod reproduces. The number of spawn is tremendous, and the loss of so much energy causes a large diminution in the vitamine content of the oil obtained at this season. The "normal

osage" at such times rises to as much as 0 mgms., instead of 2 mgms. in the best roducts.

The immature cod is carried north by his stream to the region about Finmarken. Their arrival coincides with the sudden remarkable growth of marine plants, diatoms, rich in vitamines, which, at the coming of the sun, fill the sea until it looks like a muddy pond. On these plants feed microscopic marine animals of all sorts, such as "Calanus" of the lobster family. These in turn are food for a slightly higher order of animal, and so on until the small fish forming the chief food of the young cod yields a meal very rich in the "Fat-Soluble A" factor, the essential vitamine of cod-liver oil. It is here that the later season of cod fishing occurs which gives rise to an oil whose normal dosage is only 2 mgms.

Dr. Drummond showed a specimen of the Fat-Soluble A which had been synthesised by the microscopic animal "Calanus" taken from the sea at Plymouth, when immersed in a solution of purely inorganic materials.

Finally, the lecturer described the chemistry of the vitamine. It is not, as popularly supposed, very unstable, as is shown by its survival after the saponifiable matter has been removed from cod-liver oil by boiling in alcoholic potash for 24 hours. This saponifiable matter, 2 per cent. of the whole, is golden yellow in colour, and definitely crystalline. From this can be obtained 30 per cent. Cholesterol, while repeated fractionation of the residue gives, among other products, a small quantity of cetyl alcohol. The pigmentation is probably due to a lipochrome, similar to carotene, the colouring matter of butter.

Dr. Masson, in moving a vote of thanks to the lecturer, suggested that in a few years' time, the sick child would be strengthened by a soup of animalculæ rich in vitamines.

In his reply, the President said that such was almost an accomplished fact. He was informed by Dr. Macklin, of the "Quest," that on a previous expedition in the Antarctic, an excellent soup had been made from sea-water which was thick with these microscopic animals.

F.C.R.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

SECTION I.—PHYSIOLOGY.

THE EFFICIENCY OF MAN AND THE FACTORS WHICH INFLUENCE IT.

ADDRESS BY PROF. E. P. CATHCART, M.D., D.Sc., F.R.S., PRESIDENT OF THE SECTION.

(*Continued from Page* 283).

The study of the metabolism has given little or no clue so far. Benedict and I carried out a certain amount of experimental work on this phase of the question. Our results show that the subject may be on the very verge of absolute collapse, and yet, so far as the metabolic determination goes, there is no very marked evidence of diminished efficiency in a mechanical sense. In an experiment with M.A.M., who, in the postabsorptive state, rode on a bicycle ergometer for nearly four and a-half hours until on the verge of collapse, doing 208,000 kilogrammètres of external work during the time, the metabolism was determined six times during the riding period with the following result:—

TABLE II.

Time.	Oxygen Consumption per min. in cc.	Rate of Work Revs. per min.	Net Efficiency in per cent.
8.30 a.m. (start)			
9.00 a.m.	1,967	91.3	23.1
9.45 a.m.	1,946	91.4	23.3
10.30 a.m.	1,969	91.7	23.2
11.15 a.m.	1,948	90.3	23.2
12.00 noon	2.003	89.0	21.7
	[illegible]	78.2	21.3

It will be noted, as might be expected, that there is some slowing of the rate at which the work is done, but the diminution in the net efficiency, in spite of the fact that the subject admitted he was completely done at the conclusion of the last determination, is not striking.

In other experiments where the type of muscle activity used was marching, little apparent effect on the metabolic cost was noted until extraneous muscle activity was introduced in the form of staggering as the result of exhaustion.

Obviously, then, the capacity to carry on is limited by the genesis of fatigue. But it is equally obvious in practice that a man may be engaged in strenuous labour for many hours without acute signs of impending exhaustion. How is this condition attained? There are at least four factors which, to my mind, play predominant rôles in the attainment of maximum efficiency, viz., the rate of the performance of work, the amount of rest offered or taken by the subject, the rhythm with which the work is performed, and the work habits developed by the worker. Although I shall attempt to examine each of these factors separately, it is not to be inferred that they can really be considered as independent phenomena. As a matter of fact, they are all intimately related, and usually merge into one another.

Of these four factors, probably most attention has been devoted to the rate or speed at which work is carried out. The glorification of that much misused half-truth, "Time is money," is responsible for much false physiology. Farmer, in a recent report to the Industrial Fatigue Board, laid, I think, the correct stress on the relation of speed to general industrial efficiency when he wrote: "No movement can be compared with another and said to be better than it merely on account of its speed; it should only be compared in respect to ease and final result." This is a good answer to those who believe that maximum efficiency can be best obtained by mere speeding up. Goldmark also stresses this aspect of the question. She writes: "Now just in proportion as this function of speed is developed, subject to the capacities of the human agent instead of as a driver of these capacities, it counts as a gain. Just so soon as the function of speed is dissociated from its effects on the worker we revert to the old system of pace-making and speeding."

These are the observations of field workers. Can they be substantiated by experimental work in the laboratory? Benedict and I found, for example, working with a carefully calibrated bicycle ergometer, that there was a very close connection between the speed at which work was done and the mechanical efficiency. There was a very definite falling off with increased speed, as the following table shows. Unfortunately it was impossible to get our subject to pedal slower than 70 revolutions per minute:—

TABLE III.

Revolutions per min.	*Gross Efficiency.*	*Revolutions per min.*	*Gross Efficiency.*
70	20.6	110	17.6
80	20.0	120	16.9
90	19.2	130	16.1
100	18.4	—	—

We found further that if the amount of effective muscular work done was kept constant, that the efficiency fell with an increase of speed. Thus with effective work equivalent to 1.95 calories performed at the rate of 90 and 124 revolutions per minute respectively with the lower speed, the net efficiency was 22.6 per cent., whereas with the higher speed it fell to 15.7 per cent. Or again, with effective work of 1.58 calories at 71 and 108 revolutions per minute the efficiency was 24.5 per cent. and 15.6 per cent. respectively; and finally, with effective work of 1.35 calories at speeds of 71, 94, and 105, the efficiencies were 23.1, 20.4, and 17.0 per cent.

A. V. Hill has also recently dealt with this problem in a most interesting piece of work, where the activity was strictly confined to the biceps and the brachialis anticus. He demonstrated very clearly that, in spite of the fact that the slower the contraction the greater was the amount of work done, all the advantage thus gained was rapidly neutralised and dissipated as the result of the slow contraction necessarily causing an increased degradation of energy in the way of physiological changes resulting from the maintenance of contrac-

tion. It thus followed that a slow contraction, powerful though it might be, was not necessarily one of high efficiency. The actual efficiency, *i.e.*, the ratio of the external work done to the energy degraded in carrying it out, was found to pass through a definite maximum value as the duration of the contraction increased. The maximum efficiency in his series of experiments was 26 per cent. He found that it was very rapidly attained, the optimum for the muscles investigated being apparently just under one second, but the fall which followed, as the duration of the contraction increased, was a comparatively slow one. On account, therefore, of the blunt nature of the curve the efficiency remained more or less constant over a wide range of speeds.

The load has obviously a direct connection with the speed at which work is done, but it has also a relation to efficiency. Benedict and I found, for instance, that both the gross and net efficiencies within the limits of our experiments increased with the load. The probable explanation of this result is that when light work is carried out maintenance or physiological requirements which have to be covered form a large proportion of the total energy output, a balance which is steadily altered as the amount of external effective work done increases. Incidentally, Hill drew attention to a most important factor in the consideration of the efficiency of muscle, viz., the relation between the maximal and the submaximal effort. Hill suggested that the less powerful effort was the result of the maximal contraction of only a portion of the muscle fibres, and that the fibres not directly involved in the contraction changed passively, *i.e.*, they were made to conform to the shape of their active neighbours. This, of course, will automatically lead to a considerable waste of energy in changing the form of the muscle as a whole, therefore the submaximal effort will be less efficient than a maximal effort of the same duration in time, and further "the highest efficiency of a submaximal effort is obtained in a slower contraction than that of a maximal effort."

On the other hand, when the loads become excessive there is a definite falling off, both in gross and net efficiencies. Laulanié, who also investigated this question, found that at voluntarily selected speeds, with steadily increasing load, the external work done rose with decreasing speed until the load became excessive. He maintained that there were two optima, (*a*) an economic optimum at 4 kilo. load with high efficiency, and a low oxygen consumption per kilogrammètre, and (*b*) a mechanical optimum between 8 and 12 kilo. load when the output in unit time was highest. The following table from Laulanié makes his point clear:—

TABLE IV.

Resistance in kilos.	1	2	3	4	5	6	8	10	12	15
Speed adopted, metres per sec.	1.49	1.07	0.80	0.61	0.54	0.44	0.37	0.29	0.24	0.13
Work done, kilogram-métres per 5 min.	448	642	726	778	812	853	896	905	906	570
Oxygen intake in c.c. per kgm.	3.5	2.44	2.17	2.14	2.23	2.25	2.43	2.53	3.12	5.31
Efficiency per cent.	14.1	20.4	22.9	23.3	22.3	22.1	20.4	19.7	17.0	9.4

It will be noted that when the load becomes excessive the efficiency rapidly falls away. This means that, although the effort may be continued as strenuously as before, and although the physiological cost of the effort remains at a very high level, the amount of external work done is reduced to a very low figure. The static element in the muscular effort has become dominant, and static expenditure is parasitic on dynamic work. The more static the work becomes the greater is the fall in the efficiency. Personally I am of the opinion that the severity or hardness of muscular work, *qua* the organism as a whole, is a function of the static component of the effort made. Fatigue, *i.e.*, inability to carry on, is more readily induced by static work than by either positive or negative work. The following figures from experiments which I have carried out with Miss Bedale and G. McCallum show clearly this diminution in efficiency as the static element in the work is increased:—

TABLE V.

Pulls per min.	Kgm. per min.	Cost in grm. cals. per kgm. p. sq. m.	Net Efficiency per cent.
32	40	16	8.0
12	15	17	7.5
6	7.5	20	6.0
4	5.0	31	3.0+
3	3.75	38	3.0
2	2.5	68	2.0-
1	1.25	146	1.0

Another series of experiments carried out with Burnett in another fashion led to the same conclusion.

Very closely allied with the rate of working is the rhythm with which the work is performed. Although they are not identical phenomena, they are so closely related that the habit of work may be considered along with the rhythm. Sir Charles Sherrington and Graham Brown have both shown very definitely, in connection with their work on reciprocal innervation, that a rhythmic phenomenon may be evoked in muscle by the appropriate balance of antagonistic stimuli. *Graham Brown holds that this rhythmic action is one of the most fundamental properties of the nervous system.* Everyone is well aware that once a rhythm, or the proper co-ordination in the play of a set of muscles in the performance of some definite act, is mastered, not only is the energy expenditure reduced by the exclusion of numerous extraneous muscular activities, but there is an actual *enhancement of the ease* with which we perform the specified act. Willingly or unwillingly, those who have to do much repetitive work, be it playing golf, a musical instrument, or working a machine, soon appreciate the fact, when they think about it at all, that their best and easiest *results are obtained under certain very definite conditions.* To take a single example, the work of forward progression or walking is performed most easily when we adopt our own gait. It is not a mere question of rate. In a series of experiments which I carried out with Burnett, the subject, working on a specially geared ergometer, was allowed to select his own rate of working, the load being varied from nothing to 4 kilos. *At each change of load the subject* was directed either to work rapidly or very slowly, and after a period of such work was told to adopt the rate he liked best. As the following table (Table VI.) shows, the rhythm of work was practically identical for all loads. This occurred under all conditions, provided the working spells were not of too long duration. If the work were continued over a long period, the rhythm tended to alter, to increase in speed, and if the subject became really tired, periods of rapid movement alternated with periods of slow movement.

TABLE VI.

Load in kilos.	Rate of Work per min. voluntarily selected. Exp. I.	Exp. II.	Exp. III.	Exp. IV. (Immediately after 1 hour's work at rate of 45 per min.)
0	78	80	83	—
1	80	79	79	71
2	81	80	81	—
3	80	78	83	73
4	82	77	78	—

The figures given are the averages of three or more observations made at each load. None of the observations were made in the order in which they are recorded; light and heavy loads were alternated.

(To be continued.)

MINISTRY OF AGRICULTURE AND FISHERIES.

Beneficial Insects.

Introductory.

In their relation to cultivated crops, insects may conveniently be divided into three groups, viz.:—

Pests—those which are harmful, causing by their depredations serious loss to the cultivator and a diminution of the country's food supply;

Neutral or negligible—those which do not directly influence crop production;

Beneficial—those which by predaceous or parasitic habits diminish and keep in check the numbers of the pests.

There is some overlapping between these three groups, but it is generally possible to assign an insect to one or the other.

In considering *beneficial* insects from the cultivator's point of view, it is only possible to deal with certain large groups, various members of which attack and destroy the worst insect pests to agriculture and horticulture. Of these groups, five are outstanding as amongst the very best friends possessed by the farmer, gardener and fruit-grower: they are Ladybirds, Lacewing Flies, Hover Flies, Ichneumon Flies, and Tachinid Flies. Only too frequently these insects are mistaken for foes and destroyed. It is hoped that the brief descriptions of them and short outlines of their life-histories herein given may help towards their wider recognition.

In connection with all of them one point must first be emphasised: Beneficial insects seldom, if ever, exterminate a pest, or extermination of themselves would be likely to follow. The most they do is so to check the pests (which would otherwise breed in colossal numbers) that the damage suffered by crops is reduced to an almost negligible amount. Their work of destruction goes on unobtrusively, and only fails when some influence favours the pest or acts adversely on the parasite, allowing the former to survive in such overwhelming numbers that an effective control no longer obtains. The cultivator himself must then resort to artificial measures of pest destruction, but in doing so he must remember that he is often killing both friend and foe alike. He must, therefore, having once begun, be prepared to continue his spraying or other measures, and himself carry out the work previously left to Nature.

Ladybirds.

Ladybirds are beetles which do untold good by feeding in the adult and grub (larval) stages upon Aphides (Greenfly or "Blight"). Some kinds also feed on Scale Insects, Suckers, or other pests.

The adult Ladybird is well known, and is usually respected by everybody; but in the grub stage, being so very different in appearance and somewhat repulsive to look at, it is by no means so often recognised and frequently falls a prey to the uninformed zeal of the gardener, who complains of Greenfly while he busily destroys perhaps its greatest enemy—the Ladybird grub. The appetite of these grubs is enormous, and they appear to feed almost continuously, 30 to 40 Aphides being devoured with scarcely a pause.

Ichneumon Flies.

Under this popular designation may be included several thousand allied species of insects. They are not flies in the zoological sense, but are all close relations of the bees and wasps, albeit not necessarily like them in appearance. They range in size from extremely minute insects, hardly visible to the naked eye, up to as long or even longer than the Hornet, though less heavily built. They have jaws, long antennæ, and four wings, which are always carried along the back and are small in proportion to the creature with few ribs in the supporting framework. In habit they are very active and energetic. Ichneumons probably comprise (with the possible exception of adverse weather conditions) the most potent of all the forces operating to keep in check an overwhelming increase in other insects — a misfortune which always threatens. They do not achieve this by devouring them outright as the Ladybird does, but are parasitic and lay their eggs in or upon the insects they attack. The Ichneumon grubs then feed upon the juices of their victims and come to maturity in their stead. Practically all the other orders of insects are laid under contribution. It would be quite impossible to enter here fully into the immense activities of Ichneumon Flies; suffice it to say that most of the grubs and caterpillars that destroy cultivated crops are known to be attacked. The dried skins of Aphides containing the

parasitic grub and forming a covering for it, can always be found in considerable numbers. In fact, practically all the more serious pests are destroyed by Ichneumons.

Unlike the Ladybirds and Lacewings, of which the grubs are too frequently destroyed in ignorance, the large group of parasitic insects here called Ichneumon Flies need no special plea for their preservation, for in the early stages they are out of sight or not prominently noticeable, and as adults are active, watchful, and able to take care of themselves.

Tachinid Flies.

Though Tachinid Flies do immense good in destroying caterpillars, it would be serving no useful purpose to deal with them fully with a view to preventing their destruction, for they can only be recognised by the expert entomologist. Superficially, they are much like the common House-Fly, an appearance which is also shared by several other flies which are troublesome pests. Many species of Tachinid Flies are larger than the House-Fly. A close examination of all would show them to be covered with strong bristles. Their habits are akin to those of the Ichneumon Flies, but the egg or eggs are deposited either upon the skin of the grub they attack or upon its food plant. The resulting maggots eat their way into the interior of the creature and feed there, or possibly in certain cases the Tachinid eggs may be eaten by the grub with its food, and reach its body in that way. The grubs feed within the bodies of their hosts. On becoming full-fed they eat their way out and form a puparia, very much like those of the House-Fly and on emerging from them the flies again deposit their eggs.

These insects are true flies, not like the Ichneumons, which are related to the bees. They possess but two wings, and the mouth is formed for sucking.

Hover Flies.

Syrphid Flies, or Hover Flies as they are also called, belong to the true flies, though many present a somewhat close superficial likeness to certain bees and wasps. They, nevertheless, have but two wings and sucking mouths, the main characteristics of their whole order. The Syrphid group is a large one which comprises some pests (*e.g.*, the Narcissus Flies), many kinds which are neutral, and a number which are beneficial to a high degree.

The grubs of the latter, together with the Ladybird and the Lacewing, comprise a trio of voracious devourers of Aphides or Greenfly, and are frequently found in company. There is little danger of the very active-winged adult falling a victim to the destroying hand or foot, though undoubtedly the misguided zeal of the gardener only too often finds vent against his good friend in the grub or maggot stage.

Lacewing Flies.

Lacewing Flies belong to the same class as the Dragon-Flies, have biting jaws, "feelers" or antennæ, and four wings which, with their many fine supporting ribs, have the appearance of net or lace—hence the popular name of the group. The wings, which are large, are carried flat when at rest against the sides of the body, extending beyond it and obscuring the whole hinder portion. The most familiar members of the group are beautiful green insects with golden eyes. Other species are of the same form, but smaller and a plain brown in colour.

Many Lacewings, when in the grub stage, are sometimes confused with Ladybird grubs, and are not inferior to them in their inexhaustible appetite for Aphides. They may also attack Scale Insects or other pests, and some have the remarkable habit of covering themselves with small pieces of lichen, bark, &c., or even with the empty skins of their victims. All Lacewings are valuable, and should on no account be destroyed.

Artificial Encouragement of Beneficial Insects.

Five kinds of insects extremely beneficial to the farmer, gardener and fruit-grower—in fact, to all whose activities take them amongst plants for their cultivation—have been touched upon. The five taken do not exhaust the list, but are chosen as being by far the most important.

Apart from the obvious duty of avoiding their destruction whenever possible, the question naturally arises as to whether beneficial insects can be increased or encouraged artificially. In this connection there are two distinct possibilities: (1) the introduction of new kinds of parasitic insects into countries in which they do not already exist; (2) the increase by artificial means of parasites already established in a country. With regard to the first possibility, it has been clearly demonstrated that

where a foreign pest has been introduced into a country without its parasites, then great good may result if such parasites are brought in and released. Thus, if England is so unfortunate as to be colonised by a foreign insect, one of the methods of defence will be to make sure that all the invader's parasites and diseases are introduced as well. An instance in which this method of pest control has proved a great success is that of the destructive Australian Scale Insect (*Icerya purchasi*, Mask.), which has spread from Australia to other countries. It is difficult to control by artificial means, but is kept down completely by its natural enemy, a Ladybird (*Vedalia cardinalis*, Muls.), which is now introduced to any country in which the Scale Insect obtains a foothold. In the same way Ichneumons have been introduced into America and other countries to combat foreign insect enemies which have already established themselves.

Under these conditions, artificial encouragement of parasites is a proved success, but the case is far otherwise when attempts are made to increase artificially the numbers of a parasite already plentiful. It cannot be said that attempts to his end have been generally successful, and it is only under special circumstances that even hopeful results can be claimed. The most usual condition for success—and no case exists in Britain—is where there are great climatic differences between different parts of a country. Thus, in certain parts of the U.S.A., Ladybirds migrate to the mountains in the autumn, and spend the winter in large colonies, only working down to the low ground again when warmed by the spring weather. Naturally the warm weather first reaches the valleys—while the mountains are still cold—and thus pests, which have spent the winter in the valley, get a start and can breed for a time free from their Ladybird enemies. By collecting the Ladybirds from the hills, where they occur together in millions, they can be brought to the valleys and sold by the pound! They are then released as soon as the pests begin to appear in spring.

A second case in which artificial assistance can be given to the control of pests by parasites is where it is necessary to collect by hand large numbers of the pest. The best instance of this is shown by the Apple Blossom Weevil* (*Anthonomus pomorum*, L.), which causes "capped blossom," and is one of England's most serious apple pests. If the capped blossoms are collected before the beetles have emerged, many of the blossoms will contain, not weevils, but an Ichneumon parasite (*Pimpla pomorum*, Ratz.) which has killed the weevil. In the case of one Cambridge orchard, Imms† has shown that as many as 26 per cent. of the destroyed blossoms contained Ichneumons. Now, if instead of burning the collected blossoms, they are placed in a muslin cage, the Ichneumons can all be released and the weevils killed, with the result that far more parasites should be available next year to kill a smaller number of pests. This method of dealing with Blossom Weevil has never been tried in England, but in France, in one case at all events, success is claimed.

Yet another condition favourable to the encouragement of parasites is sometimes found when pest and parasites leave their pupæ at different seasons. In the case of the Gout Fly, for instance, it appears that whereas the fly comes out about harvest time, the parasites remain within their pupæ in the barley, which are threshed out in the drum and appear in the "cavings." If the latter are burned, the parasites only are destroyed, while, if left, they will come out later and assist in controlling the fly.

Lastly, conditions for success may be found in the case of plants grown under glass. If a really destructive parasite of any of the more serious glass-house pests—such as the White Fly—can be discovered, it would pay to keep a stock going to distribute when needed in any infested house. The discovery of the parasite in this case is of course the first step.

These cases are all mentioned to show that while it is necessary to be sharply on the look-out for any means of encouraging parasites, yet, in Britain at all events, the chances are not very many. We can be thankful for the help already given by them, which is inestimable, but we cannot yet manage that they shall do all the work, and artificial control measures are therefore needed.

Nevertheless recognition of Beneficial Insects should be widespread and their destruction avoided whenever possible, for all alike ultimately share the benefits they confer. Without Beneficial Insects cultivation would be impossible.

* *See Leaflet No. 15, to be obtained from the Ministry and also included in Sectional Volume No. 2, price 10d., post free.*

† (*Annals of Applied Biology, Vol. IV.*, p. 211).

MEETINGS OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, NOVEMBER 16, 1922, AT 4.30 P.M.
Papers read:—

Prof. A. S. EDDINGTON, F.R.S.: *The Propagation of Gravitational Waves.*

J. H. JEANS, D.Sc., SEC. R.S.: *The Theory of the Scattering of a- and β-Rays.*

Prof. A. P. CHATTOCK, F.R.S., and L. F. BATES: *On the Richardson Gyromagnetic Effect.*

P. M. S. BLACKETT: *On the Analysis of a-Ray Photographs.* Communicated by Sir Ernest Rutherford, F.R.S.

J. H. JONES: *The Kinetic Energy of Electrons emitted from a Hot Tungsten Filament.* Communicated by Prof. O. W. Richardson, F.R.S.

W. WILSON, D.Sc.: *The Quantum Theory and Electromagnetic Phenomena.* Communicated by Prof. J. W. Nicholson, F.R.S.

S. MARSH and A. E. EVANS: *On Measurements of Electrode Potential Drop with Direct Current and Alternating Current Elecrolysis.* Communicated by Dr. E. H. Griffiths, F.R.S.

A Chinese Chemical Society has been formed in California, with the intention of bringing all Chinese engaged in work in chemistry in America into more intimate relationship professonally and socially.

SOCIETY OF GLASS TECHNOLOGY.

Owing to the General Election falling on Wednesday, November 15th, 1922, the meeting of the Society due on that date will be postponed for one week, and will be held accordingly on Wednesday, November 22nd, in the Applied Science Department, The University, St. George's Square, Sheffield, at 3 p.m.

AGENDA.

1. Minutes.
2. Applications for membership.
3. Award of the "Frank Wood" Medal.
4. The President will speak briefly on "*The Present State of the Glass Industry in Czechoslovakia.*"
5. To receive and discuss the following papers:—

(a) "*The Changes in the Early Stages of the Melting of Glass Batches,*" by MORRIS W. TRAVERS, D.Sc., F.R.S., F.I.C.

(b) "*The Production of Colourless Glass in Tank Furnaces with Particular Reference to the Use of Selenium,*" Part II., by A. COUSEN, B.Sc., A.R.C.S., and PROF. W. E. S. TURNER, D.Sc.

AWARD OF THE "FRANK WOOD" MEDAL.

To mark the services to the Society of Mr. Frank Wood, First President, the Society in 1919 raised by subscription a sum of £105 8s. 6d., which was given to the University of Sheffield to provide a Medal and Prize to be awarded annually to the student who attained the highest standard in the examination for the degree of B.Sc.Tech. in Glass Technology.

The medal has been designed by Mr. Percy Metcalfe, of the Royal College of Art. Copies of it will be on view at the meeting.

By request of the University, Mr. Frank Wood himself will present the Medal to two students who have won it, namely:—

Mr. G. G. Middleton, B.Sc.Tech., in 1921, and Mr. H. W. Howes, B.Sc.Tech., in 1922.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

ORDINARY MEETING, 1ST NOVEMBER, 1922.

Held at the Chemical Society's Rooms, Burlington House, Mr. P. A. Ellis Richards (President) in the chair.

Certificates were read for the first time in favour of:—

Messrs. Henry Aldons Bromley, Robert Faraday Innes, F.I.C., Osman Jones, F.I.C., Alan West Stewart, D.Sc., A.I.C., William Heaton Thorns, Walter Horace Clulow, William Plenderleith Lewellen Hope.

Certificates were read for the second time in favour of:—

Messrs. George Scott Robertson, D.Sc. (Dun.), F.I.C., Frederick John Martin, M.A. (Cantab), A.I.C., Frederick Stanley Shadbolt, A.I.C.

The following were elected members of the Society:—

Messrs. Archibald Steele Whamond, Thomas John Ward.

The following papers were read:—

"*The Colorimetric Estimation of Pyrogallol, Gallotannin and Gallic Acid,*" by C. AINSWORTH MITCHELL, M.A., F.I.C.

"*The Estimation of Narcotine and Papaverine in Opium*," by H. E. ANNETT, D.Sc., F.I.C., and M. N. BOSE, M.A., and "*The Estimation of Codeine*," by H. E. ANNETT, D.Sc., F.I.C., and R. R. SANGHI.

"*The Estimation of Morphine*," by J. R. NICHOLLS, B.Sc., F.I.C.

"*Further Notes on the Estimation of Potassium; By Perchlorate and Cobaltinitrite Methods*," by R. L. MORRIS, F.I.C.

"*THE COLORIMETRIC ESTIMATION OF PYROGALLOL, GALLOTANNIN AND GALLIC ACID*," BY C. AINSWORTH MITCHELL, M.A., F.I.C.

The author has devised a ferrous tartrate reagent which can be used for the detection and estimation of pyrogallol, gallotannin and gallic acid. The violet coloration produced in the reaction is due to the pyrogallic group in these substances and, applied quantitatively, affords a measure of that group in different compounds. The reaction throws light on the constitution of gallotannin. The results obtained with it do not agree with the long accepted formula for gallotannic acid, or with the formula of Emil Fischer's synthetic gallotannin, but are much more in accordance with the formula recently suggested by Nierenstein, at any rate in the case of tannin from China galls, and they decide a doubtful point in connection with that formula.

In using the reagent for the estimation of gallotannin in the presence of gallic acid the substances are estimated together colorimetrically in terms of gallic acid or pyrogallol. The tannin is then precipitated with quinine hydrochloride and the gallic acid again estimated in the filtrate. The difference between the two results, multiplied by a factor gives the gallotannin. The method has been applied to the estimation of tannin and gallic acid in various natural and commercial products such as galls, tannin extract, myrobalans, divi-divi, tannin lozenges, tea, etc. It has also been used to follow the course of the enzymic hydrolysis of gallotannin, and to study the nature of the changes which occur in the technical process of roasting myrobalans

"*THE ESTIMATION OF NARCOTINE AND PAPAVERINE IN OPIUM*," BY H. E. ANNETT, D.Sc., F.I.C., and M. N. BOSE, M.A.

The authors, being engaged in experiments on poppy selection with a view to the production of medicinal opium of high quality, have found it necessary to devise processes for the estimation of the principal alkaloids of opium, which can be carried out on the very small quantities of the drug (say 1 to 2 grams) obtainable from the few plants produced in such selection experiments. In the case of narcotine and papaverine they have utilised an old observation of Plugge's that on addition of sodium acetate to an aqueous opium extract, narcotine, papaverine, and narceine are precipitated. The authors find that, given the right conditions, the first two are precipitated completely, that the narceine carried down at the same time can be washed away with water, and that in the washed precipitate after further purification, narcotine can be estimated polarimetrically.

"*THE ESTIMATION OF CODEINE*," BY H. E. ANNETT, D.Sc., F.I.C., and R. R. SANGHI.

This is an improved and simplified form of the process described by Annet & Son in 1920 (*Analyst*, 1920, XLV., 321) in which the codeine is extracted by toluene from an aqueous alkaline extract of opium, converted into the hydrochloride, purified by re-egtraction with toluene, and finally converted into hydrochloride and weighed as such.

"*THE ESTIMATION OF MORPHINE*." BY J. R. NICHOLLS, B.Sc., F.I.C.

If two volumes of 50 per cent. alcohol are shaken with one of chloroform and allowed to separate, the two layers are about equal in volume, the upper being about 33 per cent. alcohol, and the lower having an approgimate chloroform-alcohol ratio of 2:1.

If the 50 per cent. alcohol contains morphine liberated by means of ammonia, the base distributes itself between the two layers so that about 85 per cent. of the total morphine is in the lower layer. When this layer is run off the addition of half a volume of alcohol to the upper layer brings is to approximately 50 per cent. alcohol aagin, and after shawing with 1 vol. of chloroform, the second lower layer contains about 85 per cent. of the remaining morphine. Two such extractions, therefore, remove over 99 per cent. of the base, and in practice 4 extractions will only be necessary to remove more than 0.1 gram of morphine.

The presence of the alcohol retards or prevents the crystallisation of the base from the upper layer, and ensures a rapid separation. The combined extracts can easily be evaporated on the steam bath.

For general application of this method of extraction, other alkaloids are removed by means of ether and chloroform from a suitably prepared aqueous solution made alkaline with sodium, potassium or calcium hydroxide, 1 vol. of the solution is mixed with 1 vol. of alcohol, the fixed alkalinity removed by a slight excess of ammonium sulphate, and the morphine extracted as described.

Small amounts of other substances may also be removed, but these do not interfere with the estimation of the morphine either by titration, or colorimetrically or polarimetrically.

"FURTHER NOTES ON THE ESTIMATION OF POTASSIUM; BY PERCHLORATE AND COBALTINITRITE METHODS," BY R. L. MORRIS F.I.C.

This paper is a continuation of a previous paper by the same author (*Analyst*, 1920, XLV., 349). A modification suitable for the direct estimation of Potash in the presence of phosphates of calcium, magnesium, iron, etc., is described. It is stated that sulphates should always be removed, and a method of precipitating these by barium chloride is put forward which reduces the usual loss of potash in the barium sulphate precipitate to negligible amounts.

Drushel's modification of the cobaltinitrite-permanganate process is shown to give trustworthy results, more especially for small amounts of potash, but some experience is necessary. Half saturated sodium chloride solution should be used for the final washing of the precipitate, and sulphates have no influence on results.

THE FARADAY SOCIETY.

ANNUAL GENERAL MEETING, 1922.

The Annual General Meeting, 1922, will be held in the Rooms of the Chemical Society, Burlington House, W.1, on Monday, November 20, at 7.45 p.m.

AGENDA:

1. Receive Report of Council and Accounts.
2. Elect Officers and Council as per nominations already announced.
3. Elect Honorary Auditors.
4. Votes of thanks.

ORDINARY MEETING, 8 P.M.

The following papers will be presented:

"Intramolecular Ionisation," PROF. T. M. LOWRY.

"On the Viscosity- and Molecular Dimensions of Hydrogen Selenide," C. J. SMITH.

"The Hydrogen-ion concentration of Natural Waters and Etching Reagents in relation to Action on Metals," W. R. G. ATKINS.

"The Scattering of Light by Organosols and Gels of Cellulose Acetate," E. W. J. MARDLES.

"Studies of the reversible sol to get transitions in non-aqueous systems," E. W. J. MARDLES.

Contributions to the discussions are invited from members and others unable to attend the meeting.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

ARRANGEMENTS FOR FIRST PART OF SESSION 1922—1923.

Ordinary Meetings of the Institution.

(Thursdays at 6 p.m. Light Refreshments 5.30 p.m.)

30 Nov., 1922: W. A. GILLOTT, *"Domestic Load Building; a few Suggestions upon Propaganda Work."*

7 Dec., 1922: A. M. TAYLOR, *"The Possibilities of Transmission by Underground Cables at 100,000/150,000 Volts."*

14 Dec., 1922: J. CALDWELL, *"Electric Arc Welding Apparatus and Equipment."*

4 Jan., 1923: F. CREEDY, Lecture on *"Variable-Speed A.C. Motors without Commutators"* (to be followed by a discussion).

18 Jan., 1923: G. H. NELSON, *"Works Production."*

6 Feb., 1923 (Tuesday): ANNUAL DINNER, at the Hotel Cecil (7 for 7.30 p.m.)

[DE]PARTMENT OF SCIENTIFIC AND [IN]DUSTRIAL RESEARCH, 16, OLD QUEEN ST., WESTMINSTER, LONDON, S.W.1.

[TE]CHNICAL RECORDS OF EXPLOSIVES SUPPLY, 1915-1918.

No. 9.—Heat Transmission.

A special series of reports is being pub[li]shed for the Department of Scientific and [In]dustrial Research, in order to make [a]vailable, for the benefit of the industries [c]oncerned, results of scientific and indus[tr]ial value contained in the technical re[c]ords of the Department of Explosives Sup[p]ly of the Ministry of Munitions. The [p]reparation of the summaries of informa[t]ion was begun by the Ministry of Muni[t]ions at the close of the war, and arrange[m]ents were afterwards made for the De[p]artment of Scientific and Industrial Re[s]earch to complete them.

Eight reports of the series have already [b]een published, viz.:—

No. 1: Recovery of Sulphuric and Nitric Acids from Acids Used in the Manufacture of Explosives: Denitratiou and Absorption. Price, 12s. 6d. (by post 13s.).

No. 2: Manufacture of Trinitrotoluene (TNT) and its Intermediate Products. Price, 17s. 6d. (by post 18s.).

No. 3: Sulphuric Acid Concentration. Price, 12s. (by post 12s. 7d.).

No. 4: The Theory and Practice of Acid Mixing. Price, 12s. (by post 12s. 6d.).

No. 5: Manufacture of Sulphuric Acid by Contact Process. Price, 25s. (by post 26s.).

No. 6: Synthetic Phenol and Picric Acid. Price, 15s. (by post 15s. 7d.).

No. 7: Manufacture of Nitric Acid from Nitre and Sulphuric Acid. Price, 10s. (by post 11s.).

No. 8: Solvent Recovery. Price, 3s. (by post 3s. 3d.).

The present report, which is the last of the series, deals with the problems of heat transmission in relation to factory practice, thte subjec matter being arranged under the following headings:—

Theoretical Section—Fundamental principles, Criterion for turbulence, Determination of coefficients of transmission, Application of method of dimensions, Application of coefficient of transmission to specific problems, Construction of alignment charts.

Experimental Section—Method of investigation, [illegible] of experimental results, Acid coolers at Queen's Ferry, Water economy and efficient cooling, Lead cooler in denitration plant, Superheater in denitration plant, On effect of stirring, Surface condensers, Heat interchange in a cylinder in which a heat-producing reaction takes place, Surface loss.

Application of the Principle of Quinan's Bubbler-Scrubber to the Cooling of Condensing Water—Amount of air passed through $\frac{1}{8}$ in. diameter hole for various pressure differentials, Velocities or various pressure differentials, Volume of air which will pass through plate, Temperature gradient of water passing over 1 ft. length of plate for various velocities, Air efficiency, Air required to cool 1,000 lb. water per hour, Power required, Summary.

The report is illustrated by diagrams.

Copies can be obtained from the Sale Office, H.M. Stationery Office, Kingsway, London, W.C.2.

DIACETYLACETONE.

BY J. N. COLLIE AND MISS A. A. B. REILLY.

These authors show that the reactions of diacetylacetone are not consistent with a triketone formula, or one containing ordinary hydroxyl groups. A ring formula is suggested as possible. Diacetylacetone is prepared by treating dehydracetic acid with HCl, and removing the excess of the latter by distillation under reduced pressure. The residue is treated with caustic soda solution and barium hydroxide, and the yellow precipitate, on boiling, collected, decomposed with HCl and extracted with $CHCl_3$. After recovering the solvent, the residue is fractionated under reduced pressure. On solidification of the distillate a molecular change occurs, as noticed by the alteration in refractive index. The residue in the flask was dissolved out with alcohol as a colourless crystalline mass $C_{14}H_{14}O_3$. Diacetylacetone reacts with phenylhydrazine giving a compound $C_{19}H_{20}N_4$, M.P. 142° C. The semi-carbazone obtained by treating diacetylacetone with a slightly alkaline solution of semi-carbazide hydrochloride was separated as long crystals M.P. 203° C. $C_7H_{10}O_3 + CH_5ON_3 = C_8H_9ON_3 + 3H_2O$. Several other compounds are also described. —(*J. Chem. Soc.*, 1922, CXXI., 1984-1987.)

OXIDATION OF ACETONE WITH PERMANGANATE.

By W. L. Evans and Miss L. B. Sefton.

Previous investigators have shown that acetic acid, formic acid, oxalic acid and pyruvic acid may be obtained from the oxidation of acetone, the actual products depending upon such factors as temperature and the oxidation agent used. The present authors have studied the oxidation of acetone with both neutral and alkaline permanganate at varying temperatures. The final products were oxalic acid, carbon-dioxide and acetic acid only. The equations given to express the oxidation are:—

$$CH_3.CO.CH_3 + 4O \rightarrow CH_3COOH + H_2O + CO_2$$
$$CH_3.CO.CH_3 + 7O \rightarrow (COOH)_2 + 2H_2O + CO_2$$
$$CH_3.CO.CH_3 + 8O \rightarrow 3CO_2 + 3H_2O.$$

but these do not indicate intermediate stages of the reaction. Again, the amounts of both acids and CO_2 formed were found to vary with temperature and concentration of alkali. Thus, more oxalic acid is produced at high temperatures (50°-75° C.) and higher alkali concentrations. At 164° C. and in neutral solutions, acetone should be completely oxidised by $KMnO_4$ to CO_2 only. From consideration of the reaction products it has to be assumed that iso-acetone molecules are present in aqueous acetone.

$$CH_3.CO.CH_3 \quad \cdots \quad CH_2 = C(OH)CH_3$$

In neutral solutions, acetone is dissociated into acetaldehyde and methylene

$$CH_3.CO.CH_3 \qquad CH_3CHO + >CH_2$$

and acetic acid and CO_2 arise from the oxidation of these respectively. Acetol is also an intermediate product.—(*Jour. Amer. Chem. Soc.*, 1922, p. 2276.)

REACTION OF NEUTRAL SALTS WITH CELLULOSE.

By Helen Masters.

The present paper, which gives a general survey of the subject under consideration, draws attention to the fact that when neutral salts in solution are passed through purified cellulose there appears to be some type of reaction taking place. The cellulose used was prepared from good quality cotton wool by washing with freshly distilled water. On passing a neutral solution of sodium chloride through this wool (cellulose), the former was found to react acid towards methyl orange. Further, on washing the cotton wool with water, the washings were alkaline, and the acid found in the sodium chloride solution was found to be approximately equivalent to the alkali found on washing the wool with distilled water. It is clear that this reaction is not due to any washing out of impurities in the wool, and when the latter was washed to free it from the alkali, and then again treated with a sodium chloride solution, the latter solution again assumed an acid reaction to methyl orange, while the wool was also alkaline. Wool appears to act in the opposite direction, while purified asbestos is inert to sodium chloride solutions. The characteristic behaviour noted is not confined to sodium chloride solutions alone, but is of a general nature with neutral salts. Further experimental work is in progress.—(*Jour. Chem. Soc.*, 1922, CXXI., 2026.)

GENERAL NOTES.

The plate of the Ramsay Memorial Tablet that appeared in our last issue was a reproduction of a photograph by Messrs. Elliott & Fry, Ltd. A certain number of additional copies are available, and can be obtained by application to the office of *The Chemical News*. Price 4d., post free.

We learn from the *Journal of the Canadian Institute of Chemistry* that new buildings for the Western University, London, Ont., which will ultimately cost close upon one million sterling, is shortly to be commenced, and that a contract has been signed for the science buildings and cost £100,000.

PROTECTION OF BRASS WEIGHTS.

In a paper by J. J. Manley, M.A., appeairng in the *Philosophical Magazine* for November, details are given of a method originated by Faraday for protecting metals from rust. A set of brass weights were lightly turned and polished, heated in a semi-luminous gas flame until nearly red-hot, and quenched in boiled linseed oil.

They were afterwards washed in turpentine and polished with old linen.

These weights have been in regular laboratory use for 16 years, and are still in good condition.

Attempts to treat other weights in the same way recently, failed to produce the same results, and the failure was found to be due to the sulphur compounds present in modern coal-gas—a modified method was devised that was quite successful.

The weights, after polishing, are evenly covered with linseed oil, and are then supported on some fragments of fused quartz or porcelain in a vitrosol muffle which is closed and heated until the weights assume a "golden tint." After cooling, they are rubbed with an old silk handkerchief.

Weights so protected are said to resemble the appearance of lacquered brass.

LITERARY INTELLIGENCE.

Messrs. J. & A. Churchill expect to publish shortly a new work, entitled, "The Theory of Emulsions and Emulsification," by Dr. W. Clayton. The volume has a foreword by Prof. F. G. Donnan, F.R.S. The Second Edition of Dr. J. D. Gimlette's "Malay Poisons and Charm Cures" is nearly ready. For this edition Sir W. Willcox, K.C.I.E., C.B., etc., has written a foreword.

Other volumes which will be published in a few weeks' time are "Applied Pharmacology," by A. J. Clark, Professor of Pharmacology, University College, and the eighth edition of "Tomes' Dental Anatomy," edited by Dr. Marett Tomes and Mr. C. Bowdler Henry.

NOTICES OF BOOKS.

The Manufacture of Dyes, by JOHN CANNELL CAIN, D.Sc. (Manchester). Published by MacMillan & Co., Ltd., London. 1922. Price 12s. 6d.

Unfortunately, death overtakes us all, and does not even wait to allow us to complete the tasks we set ourselves. This was so in the case of the late Dr. Cain, with the result that at the time of his death the work under review was still in manuscript form. We are, therefore, greatly indebted to Prof. J. F. Thorpe for undertaking the task of editing the manuscript and so providing the dye industry with the companion volume to the late author's earlier work, "The Manufacture of Intermediate Products for Dyes."

This book represents an enormous amount of effort and consists of a very readable account of the published information relating to the manufacture of dyes. Like all compilations, the value of the facts recorded depends upon the honesty of the original writers, and as some writers deceive themselves, whilst others intend to deceive, it is possible to discover inaccuracies in some of the statements made; however, in making the above statement it must be confessed that the writer has the advantage of being in possession of information which is unfortunately not available to the scientific world. As a general rule, the longer the period during which a dye has been manufactured, the greater is the tendency for information to leak out of a factory and eventually find its way into the technical literature, and so naturally the most interesting portions of the book are those sections where the leakage has been greatest. Thus the triphenylmethane colours in general, and Magenta in particular, are excellently recorded, whereas in certain other cases the patent literature has been the sole source of inspiration.

A special feature of this book is that it makes the information stored up in such rare books as "Progrès de l'Industrie des Matières Colorantes," Wurtz (1876); "Die Technik der Rosanilin farbstoffe," Mülhausen (1889); and Harmsen's Die Fabrikation der Theer farbstoffe (1889) available to the English dyestuff student in a convenient form.

Actual mistakes appear to be very few, but it appears that, in connection with the dyestuff, Gallocyanine, that an omission has been made, for the remarks commence with the preparation of pure Gallocyanine from the technical product, but no recipe is given for the production of this.

Another omission of a different character is the absence of information for the preparation of the Anthraquinone acid colours, such as Alizarin Cyanine Green.

We are of the opinion that the use of heavier type for the name of the dye at the head of the section in which the compound is described would improve what is already a well-published book. We should also like to suggest that the chemist responsible for the next edition should give the quantities of material used in the different preparations in terms of mols. as well as the actual weights, thereby improving the educational value of the work, and also facilitating the making of comparisons when several recipes are given.

To sum up, the book is a very valuable addition to our own literature of dyestuff chemistry, and should appeal to all organic chemists.

An Introduction to the Chemistry of Plant Products, by P. Haas, D.Sc., Ph.D., and T. G. Hill, A.R.C.S., F.L.S. Vol. II., pp. VIII. + 140. London: Longmans, Green & Co., 39, Paternoster Row, E.C. 1922. Price 7s. 6d. net.

The authors of this well-known work have taken the opportunity of the appearance of the third edition to rearrange and to enlarge extensively the subject matter in accordance with the very rapid developments which have taken place in this branch of bio-chemistry.

Vol. I., on the Nature and Significance of the Commoner Organic Compounds in Plants, appeared last year, and has already received notice in *The Chemical News*, 1921, CXXIII. (Aug. 26).

Vol. II. has now been issued, and deals with the metabolic processes which occur in plants. It contains a very clear account of the synthesis of carbohydrates and proteins, and the mechanism of respiration and of growth is described in adequate detail in accordance with the latest views on the subject.

Prominence is rightly given to the conditioning factors in all these processes of plant life.

The authors do not claim to have mentioned all the researches in this branch of science, yet they have included much of the recent work of importance. Even the investigations of Baly, Heilbron and Hudson upon the mechanism of photosynthesis are very fully discussed, although they were only published a few months ago in *The Journal of the Chemical Society*.

This third edition will prove to be as valuable and widely consulted as the previous ones. J.G.F.D.

Chemical Reactions and Their Equations, by I. W. D. Hackh, Ph.C., A.B. Pp. 138. London: Chapman & Hall, 11, Henrietta Street, W.C.2. 1922. Price 6s. net.

The inability to give correct equations to represent chemical reactions is a difficulty frequently found among students. This applies especially in the case of ionic equations, and the appearance of Professor Hackh's little book on this subject is very welcome.

The author does not enter into a detailed consideration of the numerous typical and important reactions, but gives a very large number of equations representing the chemical changes with which students are acquainted.

At the end of each chapter are questions which serve as a good test of the student's progress in comprehending this phase of the subject.

Several useful appendices are given at the end. The *Solubility Table* resembles one used extensively and with good results by the reviewer.

The combined index and glossary should also prove useful. J.G.F.D.

New Patents.

This list is specially compiled for the *Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

27696—Mourgan, G. — Ammonia manufacture. Oct. 12.

28225—Chemical Research Syndicate, Ltd.—Conversion of aromatic ring compounds into motor spirits. Oct. 17.

28600—Lush, E. J.—Method of activating and reactivating metallic catalysts. Oct. 20.

28584—Soc. Anon. La Ceramique Nationale.—Apparatus for manufacture of ceramic tiles. Oct. 17.

28381—Williams, J. G.—Process for manufacture of salts derivable pyrogenously from metallic ortho-phosphates.

Specifications Published this Week.

186635—Society of Chemical Industry in Basle. and Straub, F.—Manufacture of chromium compounds of azo-dyestuffs.

167464—Manufactures de Produits Chimiques du Nord Etablissements Kuhlmann.—Mechanically-operated furnaces for roasting pyrites or like ores

186840—Woodlands, Ltd.—Production of hydrogen peroxide.

186859—Imray, O. Y.—Manufacture of B-thionaphthisatin.

Abstract Published this Week.

Ammonia.—Patent No. 185179.—An improvement in the plant for the catalytic synthesis of ammonia has been Patented in this country by Messrs. L. Casale and R. L'Epreste R., 9, Via del Parliamento, Rome. The apparatus is constructed of three concentric tubes, the outer being the pressure tube, the middle one containing the catalyst, and the inner one provided with a heating element; and the disposition of the gas connections is such that the entering gases pass first between the outer and middle tubes, then traverse the inner tube, and are finally conducted through the contact material. By this means, the internal wall of the pressure tube is protected against excessive heating.

Messrs. Rayner & Co. will obtain printed copies of the published specifications, and forward on post free for the official price of 1s. each.

THE CHEMICAL NEWS,

VOL. CXXV., No. 3267

A GASOMETRIC METHOD OF ESTIMATING THE HALOGEN IN ORGANIC COMPOUNDS.

By ALEXANDER KILLEN MACBETH.

Some time ago it was pointed out (Baillie, Macbeth, and Maxwell, T., 1920, CXVII., 880) that tetranitromethane was readily reduced by solutions of hydrazine hydrate, and it was observed that the oxidation of the latter reagent involved the quantitative liberation of nitrogen. When the reaction was carried out in a nitrometer, measurement of the liberated nitrogen furnished the basis of a method of estimating the amount of the nitro-compound present in solution. The reaction was extended to the halogen derivatives of nitroform after a new method of preparing these compounds was developed which rendered them available in a pure state (Macbeth and Pratt, T., 1921, CXIX., 354, 1356).

Examination of the different types of organic compounds which contain labile halogen atoms indicates that they may be divided into two classes. On the one hand we have such substances as the acid chlorides which are characterised by the facility with which they undergo hydrolysis, and by the ease with which the halogen reacts with ammonia and with hydrazine to give the corresponding amides or hydrazides. On the other hand, we have substances like chloro- and bromo-trinitromethane which oxidise hydrazine, and do not give a double decomposition reaction with ammonia: compounds of this type are not easily hydrolysed.

If the structures of the different halogen compounds are examined with special reference to the polarities of the constituent atoms (and especially oxygen atoms in the α-position to the halogen) it is seen that the halogen atom in the two classes referred to differs in electrochemical nature. In the acid chlorides the halogen atom is electronegative; in chloro- and bromo-nitroform it possesses a ninduced electropositive character (T., 1922, CXXI., 892).

Other compounds containing an "electropositive" halogen atom of this type are also acted upon by reducing agents, and the halogen is quantitatively removed by such reagents as hydriodic acid, titanous salts, and hydarzine. The action of hydrazine has been employed as the basis of a gasometric method of estimating such compounds, and as the method is a very convenient one the procedure may be briefly described.

A van Slyke nitrometer is well adapted for the process, and in the estimation 1 cc. of hydrazine hydrate (50 per cent. solution) is run into the deaminising vessel, the three-way tap being turned to allow the displaced air to escape. The tap is now turned into connection with the graduated column, and 5 cc. of a solution of the halogen compound introduced into the deaminising vessel. The nitrogen is steadily evolved, the time required for the reaction to complete itself varying with the nature of the halogen compound and the strength of the solution. With chloro- and bromotrinitromethane all the nitrogen is liberated in the course of one minute: with ethyl bromoisosuccinate, the reaction extends over six or seven minutes. The volume of gas in the graduated column is noted when the temperature is in equilibrium, and the volume of solution introduced during the estimation is deducted. Calculation of the weight of nitrogen evolved leads to the amount of halogen (or halogen compound) employed. Acetobromoamide and dibromomalonic ester, for example, react according to the equations,

$$2CH_3CONHBr + NH_2.NH_2 = 2CH_3CONH_2 + N_2 + 2HBr.$$
$$Br_2.C(CO_2Et)_2 + NH_2.NH_2 = CH_2(CO_2Et)_2 + N_2 + 2HBr$$

In the higher substituted chloro- and bromo-malonic esters reduction is very slow and is not complete above the propyl-compound; this is probably due to a steric hindrance effect.

The method has been applied with success to the following compounds, amongst others. Chloro- and bromo-trinitromethane, dibromodinitromethane, α-bromo-$\alpha\alpha$-dinitroethane, phenylbromodinitromethane, benzenesulphondichloroamide, chloramine T, dichloramine T, N-chloroacetanilide, acetobromoamide, ethyl bromo- and dibromo-, chloro- and dichloro-malonic esters, propyl bromomalonate, ethylbromoisosuccinate, etc., from which the halogen is completely

removed. It has also been employed with compounds of the type 4-chloro-4-bromo-1:1-dimethyl*cyclo*hexane-3:5-dione, and the 4:4-dibromo-compound; *cyclo*hexane-*spiro* 4chloro-4-bromo-*cyclo*hexane-3:5-dione and the 4:4 dibromo compound. One bromine atom is quantitatively removed from these compounds by hydrazine hydrate, but the corresponding dichloro-compounds and the monohalogen derivatives are unattacked by this reagent in the cold (see also T, 1922, 121, 904, 1116, 2169).

"ISOTOPES."

A Joint Meeting was held on Friday, November 3rd, of the Manchester Literary and Philosophical Society, and the Manchester Sections of the Society of Chemical Industry, the Society of Dyers and Colourists, and the Institute of Chemistry. The meeting took place in the Textile Institute.

Prof. W. L. Bragg, F.R.S. (representing the Manchester Literary and Philosophical Society) presided over the meeting, which was a very large one.

Mr. F. W. Aston, D.Sc., M.A., F.R.S., of Trinity College, Cambridge, read a paper entitled "Isotopes."

Dalton's atomic theory postulated that atoms of the same element were equal in weight. Beyond mere speculation the first attack on the validity of this wholly unproved hypothesis was made about 1910, when Soddy put forward his theory of Isotopes and predicted the existence of varieties of lead having different atomic weights, a prediction amply verified later. The same possibility was suggested in the case of the non-radioactive elements by the positive ray analysis of Neon. By this analysis one compares the weights of individual atoms, and this can now be done with an accuracy of one part in a thousand by means of the mass-spectograph. This instrument gives a focussed spectrum depending only on the weights of the particles forming the positive rays, and as these are charged atoms and molecules, their weights can be directly compared. It is found that many, probably the majority, of the elements consist of mixtures of Isotopes. Thus chlorine (atomic weight 35.46) consists of two of atomic weights 35 and 37 respectively. Some of the heavier elements are exceedingly complex, xenon having no less than nine constituent Isotopes. By far the most important result is that the atoms of all elements except hydrogen have integral weights when expressed on the oxygen scale to a considerable degree of accuracy. This "whole number" rule enables sweeping simplifications to be made in our ideas of mass. All atoms may now be considered simply as different aggregations of primordial atoms. The latter are of two kinds, positive and negative, protons and electrons, the particles of electricity itself. The fact that the elements of fractional atomic weights are mixtures of isotopes of whole number atomic weight explains at once anomalies in order such as the atomic weights of argon and potassium. On Rutherford's Nucleus Atom theory isotopes are elements whose atoms have the same net positive charge on their nuclei (Moseley's atomic number), but different numbers of protons and electrons in these nuclei and therefore different weights. Isotopes have practically identical chemical and optical properties. Their separation is a matter of extreme difficulty, and only the minutest changes of atomic weight have been experimentally achieved so far. The weight of the hydrogen atom is found to be greater than unity, this is of great importance, for if it were possible to transmute hydrogen into any other element prodigious quantities of energy would be liberated. This transmutation is probably going on in the sun and other stars continuously.

THE EDUCATION OF THE CHEMIST.

Dr. O. L. Brady, F.I.C., addressing the Chemical and Physical Society of University College, London, on October 31st, on the "Education of the Chemist," said that the reason why the status of a chemist was not as high as that of other professions, such as medicine or law, was due in a large measure to the incomplete nature of his training. Present-day specialisation has resulted in men, who, although extremely well read in their own branch of science, have no education or interests outside their work. Chemists are not, as a rule, "men of the world," nor are they capable, by reason of their training, of interesting their directors or works-managers. The result has been that rarely does a manager make a personal friend of his chief chemist, solely because of the lack of topics of conversation and general "talk," which all chemists would readily admit is too often

invited to "shop." Consequently, the chemist is regarded more as a superior sort of workman.

Exponents of a classical education have long deplored the tendency of science teaching to eliminate the Humanities from the curricula of science students, but educationalists are at last beginning to realise that those much abused subjects, Latin and Greek, must occupy a more prominent position even in the training of chemists if clarity of thought and expression are to be achieved.

The exposition of scientific argument, said the speaker, should surely be logical, yet how few of present-day chemists possess the small knowledge necessary to express themselves logically.

Coming to a consideration of defects in the present system, Dr. Brady pointed out that rarely, in the equipment of University teachers, does a knowledge of the science of teaching have place. The result is that the most difficult part of science teaching, the instillation of the principles of Natural Philosophy, is often not well presented.

The deficiency in general knowledge extends not only to Literature and Art, but to Science itself. Few chemists, for instance, have any interest in other branches such as Botany, Biology, Zoology, yet these subjects should be common ground to all scientists. Industry at present calls for men with a knowledge of more than one subject. The modern works-manager is chosen because he is a physical chemist with an acquaintance with engineering, while the best organic chemists are those with biological qualifications. In fact, the complete chemical education must be widened to fit men for these dual capacities.

Speaking of present University difficulties, Dr. Brady mentioned that the curricula have to be adapted to three entirely different requirements. Taught side by side are those whose aim is industrial work, such as administration and analysis, those whose end is the teaching profession, and those destined for purely academic research work.

Obviously, complete co-education of all three types is impossible, and at present the courses are best adapted to the research worker. His requirements are the opportunity for reading, while actual memorisation plays only a small part. On the other hand, the prospective teacher requires a thorough groundwork in the principles of chemistry, a thing too often lacking in modern training, and with whom practical work is of minor importance. Constant practice in manipulation is the proper preparation for the analysts, in other words, a course consisting chiefly of laboratory work.

From such considerations, the lecturer drew up his scheme for an ideal education. Recognising that the present period of three years is quite inadequate preparation for a degree, he said he would like to see the Universities once again made places where a general education in all branches could be obtained. The prospective chemist, while acquiring this, could find out his natural aptitude, whether for research, the teaching profession, or industrial work. Then, at the end of three or four years, he would proceed along with others of the same mind to a Technical College or University, where the type of training suitable to his chosen career could be obtained.

BRITISH INDUSTRY AND THE CANADIAN MARKET.

MASSED REPRESENTATION OF MANUFACTURERS AT THE TORONTO FAIR.

The Federation of British Industries has decided to inaugurate a British Section at the next Canadian National Exhibition, to be held at Toronto next year.

The question of trade with Canada is of the utmost importance at the present time for more than one reason. The high tariff barrier which has been erected by the recent legislation in the United States is debarring Canadians from selling their products in the United States, with the result that they are also tending to buy less from that country. Great Britain must benefit considerably from this state of affairs. The very favourable harvest which Canada has enjoyed this year has also done a great deal to restore her purchasing power, and there is every reason to anticipate that she will become an increasingly important purchaser of British goods in the near future.

As a result of these facts considerable interest is being manifested in the Canadian National Exhibition, the most important trade gathering of its kind held on the American Continent, and possibly in the world.

Founded in 1879, the Exhibition has been held annually ever since, with a regular in-

crease both in size and in the number of visitors. It now attracts during its fortnight's run an average of about 100,000 visitors per day, and in the years since the war the attendance has increased with surprising regularity at the rate of almost exactly 100,000 per year, until this year it reached the surprising total of over 1,300,000. It is hoped that next year there will be a million and a half visitors.

The Exhibition grounds cover 264 acres, and contain 80 buildings. There is nearly one mile of water front, and, in fact, in the matter of site and organisation the show is unique. It is held for a fortnight at the latter end of August.

Although a few British manufacturers have for many years been in the habit of exhibiting at the Exhibition with marked success, the bulk of the manufactured goods exhibited have been either of Canadian or American origin, and it is felt that the participation of U.K. firms should be very much greater, in view of the opportunities for British business in Canada which exist at the present time.

It is with this aim in view that the F.B.I. has decided to start a British Section. Realising, moreover, that one of the obstacles confronting British firms is the distance from England to Canada, and the expense and trouble necessitated in arranging an individual exhibit, a scheme has been prepared in which the Federation will undertake all the preliminary work and trouble of arranging exhibits.

An adequate block of space in one of the principal buildings is being held at the Federation's option by the Exhibition authorities, and on this block it is proposed to erect a group of stalls to be placed at the disposal of British firms at advantageous terms. An expert staff from the Federation's Head Office will go to Canada some time before the commencement of the Fair, to undertake this work, and will erect the stalls, receive, unpack and arrange exhibitors' samples, and arrange also, where desired, for expert representation of any firm during the run of the Exhibition.

For this a fixed inclusive rate will be charged, and firms will be relieved of the considerable trouble and heavy expense of sending a representative of their own to arrange the exhibit. A further advantage will be the offer of small and inexpensive spaces to firms unwilling to incur the expense of a complete stall. The grouping together of British exhibits will give importance and weight to even a small exhibit which it would not possess if merely placed haphazard among other and larger displays.

In the centre of the Section will be placed a Federation stall, which will act as a general headquarters and information bureau for visitors interested in British products.

It is necessary, of course, if the "collective" exhibit is arranged that it should be well supported. A section that is too small to have an impressive effect will hardly be worth undertaking, but trade conditions generally, and the prospects of business with Canada, are such that it is hoped a great number of firms will avail themselves of this opportunity of attacking the market.

THE PRESENCE OF LEAD IN BEER.

Some references have been made recently in the public press to an outbreak of illness due to the presence of lead in beer. It appears, from a report submitted by a medical officer of health to his urban authority, that in July last a number of typical cases of lead poisoning were traced to beer retailed by a group of houses in a suburb of London. The houses in question had recently been fitted with cylindrical cast-iron tanks lined with a vitrified enamel. Samples of beer collected from these tanks were found to contain lead varying from a minute trace to over a grain per gallon. An analysis of the enamel showed the presence of some 41 per cent. of oxide of lead, and, moreover, the enamel was of so inferior a quality that it readily disintegrated when in presence of beer. It is a matter of surprise that an enamel of so unsatisfactory a character was used by the manufacturer for lining vessels destined to be used as containers of beer. The brewery who owned the houses at once had every tank removed, and no trace of lead has been found in the beer since.

In cases where casks are not used and beer is delivered in bulk, heavy earthen stoneware tanks, made in one piece and lined with a leadless glaze, have been used for cellar work. In some quarters these are being replaced by the lighter and more convenient iron tank, and those who are installing tanks would be well advised to make it perfectly clear to the manufacturers that only a leadless glaze is to be used.

It is fortunate that the outbreak was so quickly traced to its source, and by prompt action suppressed.

MISSING ELEMENTS IN THE PERIODIC TABLE.

By F. H. Loring.

If the reader will refer to a paper of mine published in *The Chemical News* (1912, vol. CVI., *p.* 37) it will be noticed that reasons are deduced for supposing that the rare-earth elements from praseodymium to the end member preceding tantalum, taken inclusively, number 13. Reproducing herebelow Table I., which is similar to the one given in my book, "Atomic Theories," page 162 (see also *Chemical News*, 1920, CXXI., p. 315; or *Science Abstracts*, 1921, p. 481, Section A.), it will be seen that 13 identified rare-earth elements form a distinct group, as is well known; but, in order to have 14 elements to fit the places demanded by the atomic-number sequence, one with an atomic number 54+7 is necessitated. This one has not been discovered.

Table I.

	O	I	II	III	IV	V	VI	VII	VIII			I	II	III	IV	V	VI	VII	(o)
B →	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	(18)
A ↓																			
2	He	Li	Be	B	C	N	O	F											
10	Ne	Na	Mg	Al	S	P	S	Cl											
18	Ar	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	(Kr)
36	Kr	Rb	Sr	Yt	Zr	Nb	Mo		Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	(Xe)
					†	19	20		22	23	24	25	26	27	28	29	30		(32)
54	Xe	Cs	Ba	La	Ce	Ta	W		Os	Ir	Pt	Au	Hg	Tl	Pb	Bi ⌇	RaF	§	(Ems.)
86	Ems	§	Ra	Ac	Th	UX2	U ⌇							←					

A+B = Atomic number. At. No. of U = 92 (H=1). Ems. = Abbreviation for Emanations.

† Continued from cerium → Pr, Nd, –, Sa, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Ct. These are the rare-earth series.
(5 6 7 8 9 10 11 12 13 14 15 16 17 18)

⌇⌇ = Radio-active series, which overlaps to Tl when all the products are inserted, only leading ones being here shown. The table is complete in respect of places, however, as the radio atoms not shown would be isotopic with those shown and fit into the places occupied by those elements shown from Tl to U.

§ No radio-atoms have been discovered which are eligible for these places.

In this Table the *usual Group* Places are indicated by the Roman numerals. The *Arabic figures* indicate the electrons in the atom which *become* the atomic numbers when added as indicated. A represents the electrons in the inner part of the atom which *do not function* in chemical reactions or combinations. B represents the electrons outside of A which *do*, more or less, function in chemical reactions or combinations.

Each symbol stands for a *place* which may *contain isotopes*, thus:—

I	I		V
Li	K	&c. . .	N
At. Wt. 6.94	At. Wt. 39.10		At. Wt. 14.008
Isotopes 6 and 7	Isotopes 39 and 41	or in some	No isotopes
Atomic Number	Atomic Number	cases no	Atomic Number
3 (or 2+1)	19 (or 18+1)	isotopes thus:	7 (or 2+5)

This Table is based upon a similar one constructed by Langmuir in elucidation of the Lewis-Langmuir theory of electrons, valency relations, etc., which govern the *chemical* and physical behaviour of the elements either singly *or in* combination, or even in a state of ionisation. For further Notes respecting this Table, see next page.

NOTES (*continued*).

It will be seen that the numbers indicated by the letter A are those of the inert gases, representing the electrons in the respective atoms of these elements. This series of numbers, 2, 10, 18, 36, 54 and 86 may be derived from the following equation due to Rydberg:—

At. No.

inert gases $= 2(1+2^2+2^2+3^2+3^2+4^2 . \ . \ .)$

Stopping off at each squared term gives the above values thus:—

$2(1) = 2$
$2(1+2^2) = 10$
$2(1+2^2+2^2) = 18$
etc.

This table presents certain misleading features because it is shown on one plane. If the reader will imagine the block of elements Li—Na to F—Cl gradually rising upwards from the plane of the paper, so that at the F—Cl side the elevation will be the greatest, he will then be able to differentiate this block in its higher places from those elements below it. The same type of gradual rise also applies to those elements terminated by Br and I, so that the levels for F, Cl, Br and I will be about the same, while manganese would be on the lower level. By this arrangement it will be seen that the two slopes blend fairly evenly at Li—Na, K—Cs. In fact, if the table is cut in two parts and pasted on wedges, a short and a long one, this idea will at once be clearer, and perfect chemical regularity will be obtained when the elements are judged by their *levels* as well as by their positions on the flat plane of the paper. Strictly speaking, the wedges would have a slight transverse slope, and a third wedge would take the remaining elements, so that the table in perspective would resemble in some respects the schemes of G. Martin and of A. W. Stewart.*

* See *Recent Advances in Inorganic and Physical Chemistry*, 4th Edition, by A.W.S.

Referring to Table I., it will be seen that there are so many elements missing from the 7th places, that this peculiarity is of special significance; but there is one element missing in the 1st place (*i.e.*, in Group I.), which is an analogue of cæsium. Commenting on this peculiarity, both places represent extremes in chemical activity, except that the one of the rare-earth group might not represent as much activity as the corresponding ones above it. This transition in properties is not unique in the Table. The position of manganese below chlorine is a striking example; but it must be remembered that in all probability the curve of change, if it may so be expressed, is very steep at this point, as is the case in some other parts of the Table; in fact this transition in properties occurs elsewhere along the same series, *e.g.*, chromium, a metal, is not in some respects like sulphur. This form of table has to be read in a crosswise direction, so that F, Cl, Br and I are taken together, but this cross reading disappears on approaching the elements of Group I. This is fully explained on the basis of "levels" in the Notes on the Table. On this account, where the rare-earth elements cross Group VII., there would be no element closely resembling the halogens, assuming the existence of this element. For this reason, the chemical activity here referred to has to be interpreted in a way not perhaps fully appreciated as yet, and it may be related to the problem of the missing elements.

If now the atomic numbers of all these missing elements be tabulated, it will be noted that there is a certain regularity in the differences. Table II. shows this regularity, which is expressed mathematically after the manner of the Rydberg equation given in the above Notes; but, to state matters cautiously, the arithmetical treatment here given does not represent a true series, as would be the case if the lowest value were 6 instead of 2 (compare Table III.). However this may be, the regularity on the whole seems sufficiently striking to be of suggestive interest.

TABLE II.

At. No.	Diff.	Series.
87		
	2	$2(1) = 2$
85		
	10	$2(1+2^2) = 10$
75		
	14	$2(3+2^2) = 14$
61		
	18	$2(5+2^2) = 18$
43		

It would therefore seem important to distinguish between a process which, when it operates, follows a given law, and the evidence that such a process always produces something. The law may be rigorously true, as in the case of the Moseley-van den Broek sequence; but, and this is the point to be noted, the material which was neces-

sary for the production of the elements may have been at times "insufficient"—in some unknown way, perhaps one involving instability of some kind—to give expression to the law, so that lacunæ may exist which represent very few elements formed, or in rare instances, none at all.

The obvious conclusion from this study is that these missing elements will never be discovered, or if they are discovered their quantities will be extremely minute.

In conclusion, it might be worth while to bear in mind the series given by Table III., for it involves only one discordant gap which further investigation of the radio-elements might remove, though at present this seems unlikely. It is of possible interest to note that the atomic number 93 represents a limit to the series, 92 being the highest atomic number known. Extending the series in a downward direction, as shown, would involve the atomic number of scandium, and this element is known to exist only in very minute quantities relative to those elements on each side of it.

TABLE III.

At. No.	Diff.
93	
	2
UX2 = 91	
	6
85	
	10
75	
	14
61	
	18
43	
	22
Sc = 21	

UX_2 also exists in quantities relatively small compared to the radio-elements on each side of it.

SUMMARY.

(1) The absence of certain elements in the 7th places of the Periodic Table; (2) the small quantities of scandium in existence relative to elements on either side of it; (3) the missing of places I. and VII. in radioactive changes; (4) the number of existing rare-earth elements Pr to Ct inclusive being by certain considerations limited to 13, and being in harmony with a blank atomic-number lacuna 54+7; are all accounted for by one or two types of mathematical series based upon atomic-number differences, the series also having a limiting characteristic in agreement with the extent of the atomic numbers. The deduction therefrom follows that these missing elements do not exist, or if they do exist, they are present in exceedingly minute quantities. As a subsidiary development of this study, the chemical and electronic characteristics of the elements (atoms) can be elucidated by means of a table as designed by Langmuir, but arranged on short and long wedges, so that all elements on a given level will be closely allied, while the displacements along a plane will conform to the electronic states of the atoms. Extending this idea, a third very long wedge would seem necessary, which would include all the remaining elements; but its lower half would be incomplete after uranium, as the limit is fixed by the above-mentioned series.

October 15th, 1922.

MEETINGS OF SOCIETIES.

THE ROYAL SOCIETY.

ORDINARY MEETING, NOVEMBER 9, 1922.

Sir Charles Sherrington, President, in the Chair.

The following papers were read, the summaries here printed having been supplied by the authors for use at the meeting:—

PROF. H. E. ARMSTRONG, F.R.S.: *Studies on Enzyme Action.* XXIII.—*Homo- and Hetero-lytic Enzymes.*

PROF. A. V. HILL, F.R.S., and W. E. L. BROWN: *The Oxygen-Dissociation Curve of Blood and its Thermodynamical Basis.*

An attempt has been made to test the validity of the hypotheses (i) that the reaction of hæmoglobin with oxygen is represented by the equation $(Hb)_n + nO_2 \rightleftharpoons (HbO_2)$, where Hb represents the simplest possible molecule of hæmoglobin (containing one atom of iron), and n the average degree of polymerization of the molecule in the presence of the salts in blood: and (ii) that the dissociation curves of oxyhæmoglobin under various conditions can be deduced by simple application of the Laws of Mass Action.

The heat of reaction q of one grm. mol. of hæmoglobin (Hb) with oxygen has been determined by the application of the van't Hoff isochore to the effect of temperature on the dissociation curve of blood: while the heat of reaction Q of one grm. mol. of

O_2 with hæmoglobin has been measured directly in a calorimeter. The value of q/Q so found should be equal to n determined in other ways, if the hypothesis be correct, and presumably not otherwise: actually the values are very close to one another, thereby affording strong confirmation of the hypothesis.

The apparent heat of reaction of oxygen with blood may be very considerably reduced by the driving off of CO_2 by the more acid oxyhæmoglobin formed. A direct measurement of the heat of combination of CO_2 with blood has been made, and the value obtained confirms the theory that CO_2 combines with blood by taking base fro mthe ionized hæmoglobin salt to form bicarbonate, leaving the unionized hæmoglobin acid.

The heat of combination of CO with hæmoglobin in blood has been measured, and found to be about 50 per cent. greater than that of oxygen: this proves the existence of an effect of temperature on the equilibrium of O_2 and CO with blood.

H. Hartridge, M.D., and F. J. W. Roughton: *The Velocity with which CO displaces Oxygen from its Combination with Hæmoglobin.* Parts I. and II. Communicated by Prof. F. G. Hopkins, F.R.S.

Part I.

A method has been devised for determining the velocity with which carbon monoxide gas can displace oxygen from combination with the hæmoglobin molecule. Advantage has been taken of the fact that while light falls on a solution containing oxyhæmoglobin and carbon monoxide hæmoglobin, the incoming light energy changes the position of equilibrium, tending to cause a reduction in the amount of COHb with a corresponding increase of the O_2Hb. In the dark the original position of equilibrium is gradually returned to, the rate of return depending on the velocity constants of the reactions. If by a suitable technique the percentage saturation of the hæmoglohin with CO gas could be determined at various intervals of time after the light had been turned off, the velocity constants could be calculated from the determinations thus obtained.

The method used consists essentially in causing the fluid to flow through two glass tubes in series with one another. In the first the solution is exposed to a powerful light, so that the position of equilibrium is altered. In the second tube it is kept in the dark, so that the original position of equilibrium is gradually returned to as the solution flows down it.

The actual percentage saturation with CO gas of the solution at different parts of the "dark" tube was determined with the reversion spectroscope previously described. At 15° C. the two velocity constants were found to have mean values of 0.0067 and 0.55 respectively.

At 34.5° the value of K_2 was found to be .266, which gives a temperature coefficient for this velocity constant of 2.3 for a 10° C. rise of temperature. This temperature coefficient is approximately that given by many ordinary chemical reactions. With change in H ion concentration by addition of CO_2, K_2 had a value of 0.71, but the difference between this value and 0.55, previously obtained without CO_2, may have been due to experimental error, *e.g.*, to chance fluctuation in the intensity of the catalyzing light source.

Part II.

1. The method of measuring the velocity of the reaction $CO + O_2Hb \rightleftharpoons COHb + O_2$ consists in ascertaining, by means of an electrically controlled stop-watch, the time taken for the equilibrium to shift from an unstable position to a stable one, the change in equilibrium being ascertained by measurements on the absorption bands by means of the reversion spectroscope.

2. The system was changed to an unstable position by (1) subjecting the solution under investigation to the action of a powerful beam of light, which caused a new position of equilibrium to be taken up, and by (2) suddenly obstructing the light rays, thus causing the system to become unstable with a rapid return to the original position.

3. This method avoided the two errors to which that of the previous paper was liable, viz., chance fluctuations in the catalyfiing light source, and irregularity in the flow of the liquid under observation, but it involved instead the difficulty of making accurate estimations on absorption bands moving from one position in the spectrum to another.

4. Observations of K_2, the equilibrium constant, were made by method (1) at 1° C. and laboratory temperature, and by method (2) at laboratory temperature and 34° C.; the two sets of values by the two methods at laboratory temperature can, therefore, be compared. Method (1) gave

0.51 and 0.59, and method (2) 0.44 and 0.40.

5. Temperature coefficients per 10° C. were calculated from values given by the two methods; it was found that 2.3 was the value given by method (1), and 2.5 and 2.7 those given by method (2). The agreement is very close, the mean value being 2.5.

L. T. HOGBEN: *Studies on Internal Secretion.*—I. *The Effect of Pituitary (Anterior Lobe) Injection upon Normal and Thyroid-ectomized Axolotls.* Communicated by Prof. E. W. MacBride, F.R.S.

1. While pituitary feeding was found to have no influence on the metamorphosis of medium-sized or sexually mature Axolotl larvæ of *Amblystoma tigrinum*, injection of anterior lobe extracts into Axolotls of the same ages and dimensions was followed by the assumption of the adult characteristics, with rapidity comparable to metamorphosis induced by thyroid administration, and beginning about two to three weeks after the initial injection.

2. The operation of the thyroidectomy in medium-sized or mature Axolotls is described, and the efficacy of anterior lobe extracts to induce metamorphosis in thyroidless larvæ is indicated.

3. Transplantation of the thyroids of a large sexually mature Axolotl into a medium-sized individual was accomplished successfully without any production of metamorphic changes.

4. Spontaneous metamorphosis does not generally occur, as Marie de Chauvin stated, in larvæ of six to nine months when placed in shallow water with opportunities for emerging.

L. T. HOGBEN and F. R. WINTON: *The Pigmentary Effector System.*—II. Communicated by Prof. E. W. MacBride, F.R.S.

1. The existence of a nervous mechanism of pigment control is explored in the light of experiments on the section and stimulation of nerves and the administration of drugs.

2. Apart from caffeine, the only reagents found to induce melanophore contraction were those known to excite peripheral sympathetic nerve-endings, namely, adrenalin, tyramine, ergotoxine and cocaine.

3. Apart from pituitary extract, the only reagents found to bring about melanophore expansion were apocodeine and nicotine, in quantities sufficient to paralyse all sympathetic nerve-endings.

4. No unequivocal direct evidence has, however, been advanced, either in this investigation or by previous workers, to demonstrate a nervous control of pigment responses in Amphibia.

5. The possibility is indicated that the synchronous colour changes of Amphibia in response to normal environmental stimuli are determined mainly by endocrine influences.

A. FLEMING and V. D. ALLISON: *Further Observations on a Bacteriolytic Element found in Tissues and Secretions.* Communicated by Sir Almroth Wright, F.R.S.

Strains of M. lysodeikticus resistant to lysozyme action can readily be developed.

The resistance is not specific, *i.e.*, strains made resistant to one tissue or secretion are equally resistant to all tissues, whether derived from man, the lower animals, or from vegetables, showing that the lysozyme affecting M. lysodeikticus is the same whatever is the tissue it is derived from.

After solution of a large number of M. lysodeikticus there is an increase in the lytic power of the fluid, and this increase affects wholly or mainly the homologous microbe.

Different tissues and secretions vary in their capacity to dissolve different bacteria, and some tissue extracts have a marked lytic action on many of the well-known pathogenic bacteria.

THE ROYAL SOCIETY.

THURSDAY, NOVEMBER 9, 1922, AT 4.30 P.M.

Papers read:—

PROF. H. E. ARMSTRONG, F.R.S.: *Studies on Enzyme Action. XXIII.—Homo- and Hetero-lytic Enzymes.*

PROF. A. V. HILL, F.R.S., and W. E. L. BROWN: *The Oxygen-dissociation Curve of Blood and its Thermodynamical Basis.*

H. HARTRIDGE, M.D., and F. J. W. ROUGHTON: *The Velocity with which CO replaces Oxygen from its Combination with Hæmoglobin.*—Parts I. and II. Communicated by Prof. F. G. Hopkins, F.R.S.

L. T. HOGBEN: *Studies on Internal Secretion.—I. The Effect of Pituitary (Anterior Lobe) Injection upon Normal and Thyroid-ectomised Axolotls.* Communicated by Prof. E. W. MacBride, F.R.S.

L. T. Hogben and F. R. Winton: *The Pigmentary Effector System.*—II. Communicated by Prof. E. W. MacBride, F.R.S.

A. Fleming and V. D. Allison: *Further Observations on a Bacteriolytic Element found in Tissues and Secretions.* Communicated by Sir Almroth Wright, F.R.S.

It is usually possible for a Fellow to obtain an abstract of a paper in which he is interested, by application to the Assistant Secretary a day or two in advance.

Ordinary Meeting—November 2, 1922.
Sir Charles Sherrington, President, in the Chair.

The following papers were read, the summaries here printed having been supplied by the Authors for use at the meeting:—

Lord Rayleigh, F.R.S.: *Polarisation of the Light scattered by Mercury Vapour near the Resonance Periodicity.*

The chief results of the present investigation are:—

(1) White light scattered at right angles by dense mercury vapour is to a first approximation completely polarised.

(2) Ultra-violet radiation of the mercury spectrum line λ 2536, when examined immediately it enters mercury vapour in an exhausted vessel at room temperature, gives a scattered radiation which is slightly though definitely polarised.

(3) This polarisation has been observed to increase as the beam is filtered by penetration of a considerable depth of vapour. After penetration of 27.5 cm. of vapour the weaker polarised image had 60 per cent. only of the intensity of the stronger one, instead of 90 per cent. as at first. The radiation removed by the filtration appears to lie within a spectral range of about 1/100 angstrom.

G. P. Thomson: *The Scattering of Hydrogen Positive Rays and the Existence of a Powerful Field of Force in the Hydrogen Molecule.* Communicated by Sir J. J. Thomson, F.R.S.

(1) At a pressure of less than 1/100 mm. hydrogen positive rays of 10,000 volts mean energy suffer considerable small-angle scattering in a distance of 15 cm.

(2) This scattering is very much (10-20 times) greater than would be expected on theoretical grounds.

(3) There must, therefore, be a field of force in the hydrogen molecule at distances [illegible] is much stronger than would be expected from the inverse square law.

(4) A subsidiary experiment throws great doubt on Glimme and Koenigsberger's "Stosstrahlen."

H. D. Smyth: *A new Method for studying Ionizing Potentials.* Communicated by Sir E. Rutherford, F.R.S.

A new mode of attack on ionizing potential problems is suggested. The principle involved is the use of positive ray analysis to study the ions produced in a gas or vapour by the impact of slow-speed electrons of known energy. This requires that the density of gas be considerable where the energy of the impacting electrons is known, and as small as possible where the energy conditions are not known.

In the case of mercury such a localisation of vapour density was obtained by using a unidirectional molecular stream similar to that employed in a mercury diffusion pump. Ions were produced by electrons from a hot filament, and after acceleration by a large electric field were analysed by a magnetic field. In this way the values of m/e were determined approximately.

The results of the experiments on mercury indicate the formation of doubly charged ions at 19 ± 2 volts. The series relations of the enhanced spectrum of mercury are not known, but analogy with zinc and cadmium suggests an estimate in agreement with the above value. The conclusion is that the doubl eions formed at this voltage are the result of two impacts. Experiments at higher voltages, however, indicate formation by single impacts.

More highly charged ions were present in such small quantities as to make their identification uncertain even at voltages as high as five hundred. It was also impossible to identify a singly charged diatomic molecule.

I. Backhurst: *Variation of the Intensity of Reflected X-radiation with the Temperature of the Crystal.* Communicated by Sir W. Bragg, F.R.S.

Sir W. H. Bragg's early work has been extended to a variety of crystals and higher temperatures. General agreement only is found with the theories of C. G. Darwin and P. Debye.

Aluminium.—A very marked decrease in intensity was observed with rise of temperature, and fair agreement with P. Debye's theory obtained for the (100) and (222) spectra.

Carborundum.—A special furnace was constructed for temperatures up to 960° C. and no deterioration of the crystal was observed. The decrease in intensity with rise of temperature was much greater for the higher-order spectra, and different curves were obtained for the K α (333) and K β (333) spectra.

Graphite.—Only for the cleavage-plane reflection was it possible to obtain a definite temperature-intensity curve, and for the direction perpendicular to this plane an unusually high coefficient of expansion was measured.

Diamond.—No decrease in intensity was found that could be measured with certainty, and a very small thermal agitation would be expected on account of the diamond structure's great strength.

Ruby and Sapphire.—An anomalous effect was observed, since the decrease of intensity of the (111) spectra was greater than that of the (222). This may be completely explained by assuming that the atoms of the aluminium pair remain in contact and do not share in the expansion of the lattice.

S. DATTA: *The Absorption Spectrum of Potassium Vapour.* Communicated by Prof. A. Fowler, F.R.S.

(1) The principal series lines up to $m=42$ have been observed as absorption lines and their wave-lengths accurately measured. The series equation shows satisfactory agreement between the observed and the calculated values, with the exception of deviations for the last few lines, for which a possible explanation has been given.

(2) The first seven members of the series have been resolved into their components as compared with five in previous investigations.

(3) Besides the absorption of the lines of the principal series, new lines have been found to be absorbed at higher pressures, which seem to have no correspondence with the known lines in the emission spectrum.

(4) The combination lines $1s-2d$ and $1s-3d$ have been found to be absorbed, the first as a pair, confirming the presence of a satellite to the lines of the diffuse series. Their appearance in the absorption spectrum gives distinct evidence of contradiction of the selection principle.

K. R. RAMANATHAN: *The Molecular Scattering of Light in Vapours and in Liquids and its Relation to the Opalescence observed in the Critical State.* Communicated by Dr. G. T. Walker, F.R.S.

(1) Three instances of light scattering by homogeneous media are known—opalescence near critical point, scattering of light by gases, and scattering of light by liquids. The investigation was undertaken to test the view of Prof. C. V. Raman that these phenomena are fundamentally related, and that intensity of scattering in all these cases should be represented by the Einstein-Smoluchowski formula, which is more general than the Rayleigh law of scattering and supersedes it, except in the special case of gases obeying Boyle's law.

(2) Experiments on scattering of light by ether, in vapour and liquid phases, at different temperatures from 33° C. up to critical temperature 193.6° and in gaseous phase from 193.6° to 217°, are described.

(3) The results are in accord with the E.S. formula and not with the Rayleigh law.

(4) The E.-S. formula is inapplicable in *immediate neighbourhood* of critical point. The scattered light is markedly less blue here. Following the theoretical work of Ornstein and Zernike, from maximum value of intensity of scattered light the value of ϵ, radius of action of ether molecule, is deduced to be 4.6×10^{-7} cm.

(5) Light scattered at right angles to incident beam is imperfectly polarised; ratio of weak component to strong is throughout nearly 1.2 per cent., in case of vapour, while in case of liquids, ratio is 8 per cent. at ordinary temperatures, remaining constant till about 120° and then fallinp off to about 1.2 per cent. at critical point. There is no change of imperfection of polarisation on passing through critical point. Correction due to this in expression for intensity of scattered light is given.

LIST OF PROBABLE PAPERS FOR READING, NOVEMBER 23, 1922.

DR. T. E. STANTON, F.R.S.: *On the Characteristics of Cylindrical Journal Lubrication at High Values of the Eccentricity.*

PROF. F. C. THOMPSON and E. WHITEHEAD: *On the Changes in Iron and Steel at Temperatures below 280° C.* Communicated by Prof. H. C. H. Carpenter, F.R.S.

J. H. JEANS, SEC. R.S.: *The Propagation of Earthquake Waves.*

PROF. F. A. LINDEMANN, F.R.S., and G. M. B. DOBSON: *A Theory of Meteors and*

the Density and Temperature of the Outer Atmosphere to which it leads.

C. F. JENKIN: *The Fatigue Failure of Metals.* Communicated by Sir Alfred Ewing, F.R.S.

S. BRODETSKY: *The Line of Action of the Resultant Pressure in Discontinuous Fluid Motion.* Communicated by Sir George Greenhill, F.R.S.

DR. R. A. HOUSTOUN: *An Investigation of the Colour Vision of 527 Students by the Rayleigh Test.* Communicated by Prof. A. Gray, F.R.S.

ROYAL INSTITUTION.

A General Meeting of the members of the Royal Institution was held on the 6th inst. Sir James Crichton-Browne (Treasurer), in the chair. Viscount Falmouth, Dr. Michael Grabham, and Mr. N. Miesegaes were elected members. The Chairman reported the deaths of Colonel E. H. Grove-Hills, Secretary and Vice-President, and of Lord Scott Dickson, and resolutions of condolence were passed.

THE MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

JOULE MEMORIAL LECTURE.

The Hon. Sir Charles A. Parsons, K.C.B., M.A., D.Sc., F.R.S., has consented to deliver the Second Joule Memorial Lecture at the Manchester Literary and Philosophical Society's house, on Tuesday, December 5th, 1922, at 4 p.m. The title of the lecture will be, "The rise of motive power and the work of Joule."

The dinner, in honour of the lecturer, will be held the same evening at 7.30.

MINERALOGICAL SOCIETY.

ANNIVERSARY MEETING, NOVEMBER 7, 1922.
Dr. A. Hutchinson, F.R.S., President, in the Chair.

W. A. RICHARDSON: *The frequency-distribution of igneous rocks in relation to Petrogenic theories.*

The distribution of igneous rocks shows a separation into two primary types, probably corresponding to two primary earth shells, which have originated under early planetary conditions. All other rocks are normally distributed about the two primaries, and the probable cause of such a distribution is fractional crystallisation. The frequency distribution lively to result from different petrogenic processes is examined and discussed.

MISS I. E. KNAGGS: *The connection between crystal structure and chemical constitution of carbon comopunds.*

It was shown that in certain simple substitution products of methane the crystal symmetry may be predicted from the known configuration of the chemical molecule. The symmetry of a molecule of the type CX_4 is that of a regular tetrahedron, X being either a univalent atom or a group of atoms, which does not destroy the trigonal symmetry about the bonds from the central carbon atom. Compounds of this type crystallise in the cubic system. Compounds in which X is a more complex group, but sufficiently symmetrical to maintain tetragonal symmetry crystallise in the tetragonal system, most frequently in the holohedral class, in which case the crystal is considered to be built up of cells each containing eight molecules. Molecules of the type CX_3Y have one axis of trigonal symmetry, and this symmetry is preserved in the crystal, except when X is hydrogen. The orthorhombic symmetry of molecules of the type CX_2Y_2 is maintained in the crystal.

MISS C. F. ELAM: *Exhibition of coloured lantern-slides illustrating dimorphous changes in fused salts (silver nitrate, potassium nitrate, etc.).*

DR. G. T. PRIOR: *The meteoric iron of Karee Kloof, Cape Province, and the meteoric stone of Leeuwfontein, Pretoria, South Africa.*

The meteoric iron of which a mass of 92 kg. was found at Karee Kloof is a coarse octahedrite having a percentage of nickel of 8.27; the Leeuwfontein meteoric stone of 460 grams which was seen to fall on June 21, 1912, is an intermediate chondrite.

THE INSTITUTION OF MINING ENGINEERS.

ANNUAL GENERAL MEETING, NOVEMBER 16TH AND 17TH, 1922.

As previously announced, the thirty-third annual general meeting of the Institution of Mining Engineers was held, by kind permission, at the rooms of the Geological Society, Burlington House, Piccadilly, W.1, on Thursday and Friday, November 16th and 17th, 1922.

ROYAL SOCIETY OF ARTS,

JOHN STREET, ADELPHI.
169th Session, 1922-1923.

Arrangements for meetings during November, 1922:—

Monday, November 27th, 8 p.m. (Cantor Lecture): WILLIAM ARTHUR BONE, D.Sc., PH.D., F.R.S., Professor of Chemical Technology, Imperial College of Science and Technology, "*Brown Coal and Lignites.*" (Lecture 1.)

Wednesday, November 29th, 8 p.m. (Ordinary Meeting): MAJOR W. S. TUCKER, R.E., D.Sc., "*The Hot-Wire Microphone and its Applications to the Problems of Sound.*" Admiral of the Fleet Sir Henry B. Jackson, G.C.B., K.C.V.O., D.Sc., F.R.S., will preside.

OCTOBER EXAMINATIONS OF THE INSTITUTE OF CHEMISTRY.

The following candidates passed the examination for the Associateship in general chemistry:—

Chignell, Guy, B.Sc. (Lond.), University College, Southampton.

French, Herbert, Heriot-Watt College, Edinburgh.

Wild, Francis Eric, B.Sc. (Birm.), Birmingham University.

Young, Edward Bernard, B.Sc. (Lond.), East London College.

The following candidates passed in Branch (d) Organic Chemistry (under regulations in force prior to March, 1920):—

Baguely, Noel Gregory, University College, Nottingham.

Cole, Frederic, University College, Nottingham.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Section I.—Physiology.

THE EFFICIENCY OF MAN AND THE FACTORS WHICH INFLUENCE IT.

ADDRESS BY PROF. E. P. CATHCART, M.D., D.Sc., F.R.S., PRESIDENT OF THE SECTION.

(*Continued from Page* 294.)

This rhythm of work is simply a general example of the formation of a conditioned reflex. The rhythm adopted, although it may suit the worker, is not of necessity the series of muscle movements which lead to the least expenditure of energy. Most probably the rhythm selected is only in small part due to the worker's physical configuration; in greater part it is evolved in imitation of some more experienced or older worker. The average workman is not so much concerned with the diminution of the physiological cost in the performance of a given act as in the reduction of conscious effort. As Vernon states, "Experienced industrial workers unconsciously adopt habits of work which tend to the production of a maximum output with the minimum of effort."

This capacity of the organism to build up a series of conditioned reflexes is one of the potent factors in the prevention of fatigue. The organism is able not only to build up reflexes in response to the tactile impressions of the material which he handles, of the tools, their shape, weight, &c., with which he works, but even to the extent and duration of the movements which he develops in the performance of his work. The proper and effective linking up of a series of these stimuli lead to a technical rhythm which will not necessarily be identical in the case of each worker in the same shop performing the same operation, but which, viewed generally, will give a colourable representation of uniformity.

It is not, of course, suggested that the methods adopted by workers independently are the perfect methods, and that proper investigation will not discover better and easier methods of performing certain given operations. If newer and more economical methods are to be developed and brought into operation, the only real chance will be to segregate the newer young workers. Vernon gives an excellent example of the necessity of doing so. The output of a certain necessary stock article had to be increased. A factory concerned in the production turned out 5,000 per week, and this could not be increased—the regular workmen had a certain rate and habit of work. A new factory was started, staffed with hands new to the work, and after six months' practice they produced 13,000 articles per week.

There is good evidence, that of Muscio for example, that both resting and working, in addition to the individual muscle rhythm, there is a definite variation in the course of the day in the capacity to carry out work; that, in other words, a diurnal rhythm exists. There is a certain amount of evidence also in favour of the view that a seasonal rhythm exists. As Wilson has put it, "It is tempting to suppose that human performance may be dependent on a number of superimposed rhythms corresponding with the periods of work, beginning perhaps with the rhythm of the actual movement and ending with a seasonal rhythm."

Further, when efficiency is measured in terms of output it is found that there is a definite rhythm in output during the course of the working day and of the working week. It is well known that it takes an appreciable time each day to work up to full power, and this is shown distinctly in the daily output curve, which rises and then drops sharply at the end of the work period. This type of curve is not peculiar to any one industry. The rise is almost certainly due to the "limbering up," and it is probable that the fall towards the end is largely due to voluntary slowing. The total weekly output curve with the low Monday effect and the sharp fall on Saturday resembles in general shape the daily output curve. The main point about these curves is that they seem to demonstrate the absence of progressive fatigue from overwork, which would have been deduced had there been a sharp rise at the commencement of the week, followed by a steady fall.

The third of the potent factors in the control of fatigue is rest. If work is done rest is ultimately imperative. Rest not merely relaxes the muscle, allowing a more thorough and complete removal of the waste products and a more abundant supply of oxygen, but it removes the strain of attention. Rest is best obtained not by simple quiescence but by change of posture; slow movement of another type to that which produced the fatigue will, unless the organism is tired practically to complete exhaustion, give the most beneficial results. It is common knowledge that when the attention is concentrated, when our interest, either in the work or in something cognate or even foreign to it, is thoroughly aroused spells of work or intensity of effort in its performance may be borne, which under other circumstances might tax our resources to the last degree.

Forced work, *i.e.*, work carried out at a pace other than that of the performer's own selection, is much more exhausting and destructive than where the subject is permitted to work at a rate of his own selection. Laulanié, assuming that fatigue had a purely physical origin, went the length of maintaining that muscles spontaneously find the optimum rate of work where the intervals of repose exactly suffice for sufficient recuperation, so that long spells of work may be done. Such a conclusion does gain a certain amount of support from the consideration, for example, of the cardiac cycle.

So far, little attention has been paid to the duration of the rest period in relation to the work done. As a general rule, it may be said that, in the majority of occupations, although the hours of labour are continuous, the actual spells of hard manual work are discontinuous, either due to the fact that certain operations are intermittent in their severity, that supplies of material are not constant, or that, if these more or less natural conditions do not operate, rests at irregular intervals are deliberately taken by the operative.

So far as I am aware there is only one type of hard work where a definite rest period is laid down as part of the exercise, namely, in Army route marching. Marching as a costly form of energy expenditure is unique in that it is a continuous repetitive act carried on frequently for hours on end. The Regulations lay down that a definite rest period shall be taken every hour. Marching, too, is peculiar in another way, namely, that the rate of marching is fixed, *i.e.*, a certain definite rate has to be constantly maintained throughout the marching period.

(*To be continued.*)

NOTICES OF BOOKS.

Grundzüge der Angewandten Elektrochemie, von Dr. Georg Grube. Band I., *Elektrochemie der Lösungen*. Pp. XII. + 268. Dresden and Leipzig: Verlag von Theodor Steinkopff. 1922. Price unbound 8s. 4d., bound 10s. 3d.

The adverse rate of exchange makes it increasingly difficult for German scientists to procure English and American publications, and thus Dr. Grube is probably unacquainted with many recent advances in the subject of his book, conducted by workers in this country and America. Otherwise, he has given a good account of the electrochemistry of electrolytic solutions, and has included the results of researches published within the last year.

The early chapters deal in detail with the Laws of Electrochemistry.

Electro-metallurgical processes, including the refining of metals, and electrochemical methods of analysis, are then described. Next follows a full account of the electrolysis of alkali chloride solutions, together with the manufacture of hypochlorites and chlorates. There is a short but good chapter on Electrolytic Oxidation,

in which the preparation of per-salts is touched upon.

The applications of electro-chemical reduction and the technical electrolysis of water conclude this volume.

The author has dedicated his book to Prof. F. Foerster, along the lines of whose *Elektro-Chemie wässerigen Lösungen*, it follows.

The book is suitable as a textbook for students of Physical Chemistry, and also as a source of information for more experienced scientists.

The Czecho-Slovak Republic, by J. Cisar and F. Pokorny. Pp. 218. London: T. Fisher Unwin, Adelphi Terrace, W.C. Prague: Orbis Publishing Co. 1922. Price 9s.

Of the new countries that have arisen as a result of the war, not one can show such a record of progress as has been made by Czecho-Slovakia.

Whilst most European currencies are depreciating—in some cases almost to the point of collapse—the Czech crown has steadily increased in value to the present rate of 140 kronen to the pound sterling.

The authors of the present volume on their country give a complete survey of the land and its people (Part I.).

Of special interest to scientific readers are the chapters on Education, Science and Philosophy. Few of the English public are aware of the high level attained by the Czechs in these and other spheres.

The Charles University of Prague was founded in 1348, and is associated with the names of Kepler, Tycho Brahe, Kommenius, and many other distinguished pioneers. In recent times the university has produced many distinguished men of science, whose work will be familiar to their confrères in other lands.

Part II. gives a comprehensive economic survey of the new State. The mineral wealth is said to be extensive, and certainly the output of metal products is considerable.

Bohemian glassware has long been known in England, and the same applies, but to a lesser extent, in the case of porcelain and pottery.

The chemical industries have also been well developed along scientific lines.

The English general and scientific public would gain much sound, if striking, information concerning the Czecho-Slovak Republic book, the value of which is further enhanced by numerous fine illustrations.

J.G.F.D.

BOOK RECEIVED.

The Theory of Allotropy, by A. Smits, Ph.D., Translated from the German with the Author's sanction, by J. Smeath Thomas, D.Sc. Pp. XIII. + 397. 1922. Messrs. Longmans, Green & Co., 39, Paternoster Row, E.C.4. 21s. net.

New Patents.

This list is specially compiled for the *Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

28995—Aische, M. I.—Production of organic sulphonated oils of animal origin. Oct. 25.

29299—Techno-Chemical Laboratories, Ltd.—Rotatable heat-transmitting appliances. Oct. 26.

29532—West, J. H.—Manufacture of ammonium compounds. Oct. 28.

29374—Napp, H. R. — Process of manufacture of 1-phenyl-2-3-Dimethyl-4 dimethyl-amino-5-pyrazolone. Oct. 27.

Specifications Published this Week.

187016—Schmiedel, T.—Process for the production of sulphuric acid.

187035—Holmes & Co., Ltd., W.C.—Manufacture of sulphate of ammonia.

186051—Wade, H.—Manufacture of alcohol ether mixtures.

186030—British Thomson-Houston Co.—Chemical apparatus for precipitation purposes.

186129—Imray, O. Y.—Manufacture of optically-active aromatic amino-alcohols.

173520—Clerc, C.—Manufacture of magnesia from dolomite.

Abstract Published this Week.

Explosives.—Patent No. 185555.—A new preparation for explosives has been Patented in this country by Mr. H. Rathsburg, of 25, Moststrasse,

Explosive salts of tetrazol or triazol or their derivatives are used in detonators, percussion caps, &c. These salts may be mixed or precipitated simultaneously to form double or mixed crystals with other ingredients such as azoimide, mono- and polynitrated phenols and their substitution products, such as di- and trinitroresorein and trinitrophloroglucinol; also metadinitroorthodinitrosobenzene and trinitrodinitroso- -naphthol. The salts may also be granulated with paraffin or resins dissolved in benzene, xylene, or carbontetachloride. Blasting detonators may contain a top charge of such compositions, for example, a charge of lead azotetrazol over lead or cadmium tetrazylnitride over tetranitromethylaniline. The preparation of the following substances is described, namely:—(1) Tetrazol, synthetically from dilute hydrazoic acid and prussic acid, or by reduction of diazotetrazol salts by chloride of tin or alcohol, or by oxidation naphthyltetrazol or aminophenyltetrazol with potassium permanganate; (2) *tetrazylazoimide*, by splitting tetrazenes or treating tetrazylhydrazine with sodium nitrite and hydrochloric acid; (3) azotetrazol, by oxidizing amidotetrazol in alcoholic solutions with permangantes or persulphates, the amidotetrazol being obtained synthetically from cyanamide and hydrazoic acid or by reconstruction in the presence of sodium acetate of guanylazide salts formed when amidognanidine salts are diazotized; (4) oxyazotetrazol, by treating diazotetrazol salts with carbonic acid; (5) diazoaminotetrazol, by diazotizing amidoguanidine salts with sodium nitride in acetic acid solution; (6) diazotetrazol, by diazotizing amidotetrazol; (7) bistetrazol, synthetically from cyanogen gas and hydrocyanic acid solution; (8) phenyltetrazolcarboxylic acid, by boiling phenytetrazolcyanide with alcoholic potash lye; (9) methylmercaptotetrazol, by diazotizing *methylthiosemicarbazide*; (10) phenylethenyldioxytetrazol, by decomposing with alcoholic potash lye the phenylacetamidine salt thereof obtained during the diazotizing of phenyl-salt obtained in diazotizing β -naphthenylamitrazol, by decomposing the β -naphthenylamidine acetamidinenitrate; (11) β -naphthenyldioxytedine; (12) phenylglycolenyldioxytetrazol, by decompesition of phenylglycolenylamidine salts obtained by diazotizing *phenylglycolenylamidine*; (13) benzenyldioxytetrazol, by diazotizing acid benzenylamidine and decomposing the benzenylamidine salt thus obtained; (14) *m*-nitrobenzenyldioxytetrazol, by diazotizing *m*-nitrobenzenylamidine; and (15) *p*-tolenyldioxytetrazol, by diazotizing *p*-tolenylamidine and decomposing the resulting *p*-tolenylamidine salt with alcoholic potash lye.

Messrs. Rayner & Co. will obtain printed copies of the published Specifications, and forward on post free for the official price of 1s. each.

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ROYAL SOCIETY

GOVERNMENT GRANT FOR SCIENTIFIC INVESTIGATIONS.

APPLICATIONS for the year 1923 must be received at the Offices of the Royal Society not later than January 1st next, and must be made on printed forms to be obtained from the Clerk to the Government Grant Committee, Royal Society, Burlington House, London, W.1.

PATENTS.

BRITISH PATENT No. 121,294.
IMPROVEMENTS IN EXPLOSIVES.

THE PROPRIETOR of this Patent wishes to give license or to come into relation with someone competent for the industrial working of this Patent.—For particulars write to Mr. A. Van Damme, rue du Montenegro 7, Brussels.

THE OWNERS of British Patent No. 149,374, entitled: "Improved Method of Manufacturing Starch and Conversion Products thereof, and the Improved Product Obtained therefrom," desire to Dispose of the Patent or to enter into working arrangements with a likely interested Firm.

Particulars may be obtained from HERTFORD RECORD COMPANY, LIMITED, of Lindsey House, 59, Lincoln's Inn Fields, London, W.C.2.

MISCELLANEOUS.

WANTED.

NATURE, No. 2536 (June 6, 1918), No. 2580 (April 10, 1919), No. 2594 (July 17, 1919).

Engineer, April 5 and June 17, 1918.—Reply, stating price, to "A.S.," c/o *Chemical News*, 97, Shoe Lane, E.C.4.

FOR SALE.

JOURNALS of the CHEMICAL SOCIETY for 1915, and 1921, complete with index (unbound), 25s. per year.

Journal of Industrial and Engineering Chemistry 1919, £1. Apply H. E., c/o *Chemical News*, 97, Shoe Lane, E.C.4.

THE CHEMICAL NEWS,

VOL. CXXV., No. 3268

SHALL THE STATE THROW AWAY THE KEYS?

An Exposition of What Fine Chemicals Mean to the Nation.

A pamphlet with the above title has recently been issued by the Association of British Chemical Manufacturers, 166, Piccadilly, W., from whom copies can be obtained.

The pamphlet sets out the importance to the nation of the production of Fine Chemicals and the danger of reverting to the pre-war conditions of dependence upon other countries for these necessities.

The Foreword, by Sir W. J. Pope, is of such pressing interest that we have pleasure in publishing it in full:—

A Foreword

By Sir Wm. J. Pope, K.B.E., F.R.S., Professor of Chemistry in the University of Cambridge, and President of the International Union for Pure and Applied Chemistry.

The history of a nation in general falls naturally into well defined periods, each limited by some event of large national importance; the last few years have seen the close of one of the great periods in the history of many Empires. We are ourselves now in the opening years of another chapter in the history of our country, and the responsibility rests upon us of weighing up the advantages and disadvantages of the national situation and resources, and of applying the experience gained in the past to the continued development of our great national heritage.

Everyone will agree that the factors affecting our national prosperity are very different from those which ruled before the cataclysm of 1914. Until that date we had been content to amass wealth by the development of many industries in which we were pre-eminent, and to leave others, erroneously presumed to be comparatively unimportant, unlucrative, and unsuited to the British temperament, to be exploited by Germany. Thus, whilst our textile industries were the foremost in the world, we depended almost entirely on the German factories for the dyes essential to those industries. Many gloomy prophets foretold disaster from permitting the German to control many of our staple industries by allowing him a monopoly for the supply of many essential materials; these Jeremiahs vastly understated the gravity of the situation. Probably few can even yet fully realise the perils which faced us in 1915 and 1916 owing to the fact that the production of many chemical products was entirely in German hands; scarcely any British manufacturing industry can be named which was not in danger of complete stoppage owing to this fact. The production of explosives was hampered because we had but little plant for making fuming sulphuric acid, and our steel industries were endangered because Germany had a monopoly in the supply of the rare metals which are essential components of hard steels.

One of the most surprising events of the war was the facility with which, although at great cost, Great Britain organised sources of supply and improvised methods of manufacture to such effect that at the Armistice we were producing all those essentials for which we had been previously dependent on Central Europe; our success in this direction gives the lie to the statement, made so often by the German, that his countrymen believe it implicitly, that the Briton is temperamentally unfitted to become a chemical manufacturer. The question whether this country will or will not build up a sufficiently organised and completely interlocked fine chemical industry is a perpetual subject for discussion in the German technical journals; the large and illuminating literature on this matter shows that the German realises well that if we succeed our future amongst the nations is assured, but that if we fail, as he hopes, we shall have lost the peace. We shall once more have to rely upon the German factories for the supply of vital materials for our industries. Should another great European war break out we shall not be accorded leisure for improvisation; of perhaps more moment is the fact that, in the increased strenuousness of coming industrial competition, the control of key industries by Germany will provide that nation with an efficient strangle-hold upon our great staple industries. Many instances are given in the following pages in illustration of the fact that a flourishing fine chemical industry is essential to the continued success and development of all our

great manufacturing activities; hundreds more might have been given without exhausting the list. We shall never revert to a condition of healthy commercial rivalry, untainted by the hates and hopes born of the recent war, until we can convince our late enemies that it is the firm determination of Great Britain to place the manufacture of fine chemicals upon an unassailable basis; an instance may be quoted which will make this clear. One of the German fine chemical works has recently produced a material which is said to be a cure for sleeping sickness and other allied tropical diseases; this substance is now being tested under German auspices in British and Belgian Africa. Meanwhile, it was stated at the recent meeting of the German Association of Tropical Diseases that this material is the key to tropical Africa and consequently to all the Colonies, and that the German Government "must be required to safeguard this discovery for Germany; its value is such that any privilege of a share in it granted to other nations must be made conditional upon the restoration to Germany of her colonial empire." A well-organised fine chemical industry in this country could undertake a scheme of work routine-like in its simplicity, which would almost infallibly result in the discovery of a cure for sleeping sickness; if Germany is to be allowed a monopoly in curing a disease which does not occur in her own territory she will thereby forge for herself a very powerful political weapon.

The instance just quoted is interesting as illustrating one peculiarity of the fine chemical industry; it is an industry which deals in specialities, each perhaps small as measured by money values, but each of essential importance to the modern world. Unlike others, the fine chemical industry comprises a vast variety of products, many the outcome of lengthy series of manufacturing operations; it thus lends itself to a very simple method of exploitation which has been largely employed to our disadvantage during the past few years. Just after the Sankey judgment permitted the free entrance of fine chemicals into this country some years since, I had need of supplies of a number of fine chemicals and asked for quotations from Germany. I found that quite small quantities of the substances on my list which were made in this country as well as in Germany would be supplied at dumping prices; those not made in England were quoted at ridiculous prices. Isoquinoline, of which I needed some kilos, was quoted at £50 per kilogram; in my necessity I made this substance at a cost of, roughly, £1 per kilogram, but if I had had urgent need of 1,000 kilograms at short notice, I should have been forced to purchase at £50 per kilogram and should thus have contributed very considerably towards the expense incurred by the German fine chemical manufacturer in underquoting for other British-made fine chemicals and so making their manufacture here economically impossible. An identical method of treatment is applicable to many thousands of essential fine chemicals and complicates the nascent industry in this country; unless a legislative barrier is maintained, any substance—the manufacture of which is undertaken in this country—will be dumped from Germany, the expense being recouped by unduly high charges for fine chemicals not yet made heer. It is this circumstance which, in large part, necessitates untiring attention to the development of the fine chemical industry in Britain; the already long list of fine chemicals produced in this country which has been issued by the Association of British Chemical Manufacturers has to be still further lengthened. Owing to the large number of substances concerned, German dumping may confer upon one industrial a financial benefit for which another British industrial will have to pay, and the financial balance must in the end fall against this country. Unfair competition of this kind would hardly arise if we could succeed in convincing Germany that Great Britain is thoroughly determined to possess a powerful and comprehensive fine chemical industry. Many of us believe that the salvation of industry is to be found in Free Trade; Free Trade cannot be established until our competitors are convinced that preferential pricing on a basis independent of manufacturing costs is not a paying proposition.

It has been remarked above that the British war effort effectually proved the absurdity of the German advertising slogan that this country has no genius for fine chemical manufacture; the progress made since the war may well increase our confidence. Other conditions being equal, the fine chemical industry of England can compete on equal terms with that of Germany; but other conditions are not equal, and the dice indeed are heavily loaded in our favour. Whatever the shortcomings of

British institutions—and they are many—those institutions still remain the best in the world. No country enjoys so stable a system of government as ours; our commercial integrity is proverbial; our banking organisation is the most reputable which exists,* and London is probably still the financial centre of the world; our scientific men have always led; we have centuries of manufacturing experience behind us, and competent judges have often described the English workman as the best in the world. We enjoy another and a unique advantage; no natural product—animal, vegetable or mineral—can be named which cannot be supplied under highly favourable conditions from some one or other component part of the British Empire.

With all these advantages, and with the sole handicap that a few years are required for the organisation and building up of a complete network of fine chemical industries, it would be disgraceful if we should fail. We cannot fail if public opinion realises that a flourishing fine chemical industry is a vital necessity to the prosperity of our Empire and insists that national support is given to the young enterprise. We cannot remain neutral in this matter; if we withhold the necessary aid we shall thereby be giving support to the German fine chemical industries and re-establishing in an intensified form the former German control over our staple manufacturing industries. WILLIAM J. POPE.

MANUFACTURE OF SODIUM SULPHATE.

F. Mauro has described the manufacture of sodium sulphate as carried on at the work of Gewerkschaft Kaiseroda, near Salzungen, Germany. It really resolves itself into finding an outlet for large stocks of magnesium sulphate. The reaction involved is represented as:—

$$MgSO_4 + 2\,NaCl = Na_2SO_4 + MgCl_2.$$

By mixing magnesium sulphate and sodium chloride at definite concentrations and cooling down by means of compressed ammonia, white monoclinic crystals of $Na_2SO_4.10H_2O$ separate out.—(*Giornale di Chim. Ind. ed App.*, 1922, p. 453.)

THE FLASH POINT OF KEROSENE.

By E. C. CRAVEN AND B. G. BANKS.

The addition of finely divided coal to kerosene may raise the flash point through three causes, (*a*) moisture in added material, (*b*) decrease in volatile constituents, (*c*) selective absorption of volatile fraction. The sample of kerosene used gave flash point 120° F., but when treated with 44 per cent. coal dust this was raised to 122° F., and the same phenomena was observed when the oil was shaken with clay. No change in F.P. occurred when the kerosene was shaken with glass. Further experimental work showed that the low flash point constituent of kerosene is of a gaseous nature, and is probably of an unsaturated type of compound. The raising of the flash point when kerosene is shaken with such materials as charcoal, clay, etc., is due to the selective absorptive capacity of these substances for the light boiling fraction present. The amonnt of such substances present can be approximately ascertained from the difference between the Abel flash point and the Ormandy Craven flash point (see *J. Inst. Pet. Tech.*, 1922, p. 151).—*J. Inst. Pet. Tech.*, 1922, p. 490.

THE STEEL AGE.

By J. HENDERSON.*

The progress of mankind from savagery to civilisation has been popularly divided into the three Ages, Stone, Bronze, and Iron. That Stone came first is unquestioned, but whether Bronze preceded Iron or not is not quite so certain. There is no doubt as to the birth of the Steel Age, for it commenced with the reading of Bessemer's now historic paper at the Cheltenham meeting of the British Association in 1856. Before going any further it will be advisable to say a few words as to what steel is. Prior to Bessemer's invention the following definitions would serve to distinguish the two materials, wrought iron and steel.

Wrought Iron.—Iron containing practically no carbon, soft, malleable, ductile, easily welded, breaks with a tough fibrous fracture, but cannot be hardened or tempered, and will not carry a cutting edge.

Steel.—Iron containing 0.75 to 1.5 per cent. carbon chemically combined, hard, not easily welded, comparatively brittle, breaks with a close-grained fracture, can be hardened and tempered, and carries a cutting edge.

The introduction of structural steel following on Bessemer's invention brought

into use a material which in its softer varieties could be covered by the above definition of wrought iron. The following is a list of the various materials classed as steel:—

Carbon, 0.05 to 0.10 per cent., dead soft steel, used for smithing purposes, tin plate.

Carbon 0.10 to 0.20 per cent., soft steel, general structural shapes, ship and boiler plates.

Carbon, 0.20 to 0.30 per cent., general structural shapes, joists, axles.

Carbon, 0.30 to 0.40 per cent., ordinary steel castings, light rails.

Carbon, 0.40 to 0.55 per cent., heavy rails, tyres.

Carbon, 0.60 to 0.70 per cent., spring steel.

Carbon, 0.70 to 0.80 per cent., stamping dies.

Carbon, 0.90 per cent., cold setts. This marks the houndary line between the tough steels and the hard cutting steels; 0.90 per cent. carbon is toughest steel that will carry a cutting edge.

Carbon, 1.00 per cent., table knives and cold chisels.

Carbon, 1.10 per cent., drills and large files.

Carbon, 1.35 per cent., saw files.

Carbon, 1.50 per cent., lancets and razors.

This list shows the absurdity of naming the softer varieties steel, as they are so entirely different in mechanical properties from the harder varieties. The term has, however, become fixed, and will probably remain so. In later years other kinds of steel have been introduced known as alloy steels, containing manganese, nickel, tungsten, vanadium, chromium, and molybdenum.

We have no record of when steel was first discovered, but its manufacture was not placed on a definite footing until the introduction of the cementation process early in the 18th Century. This process depends on the fact that if a piece of soft, carbonless iron is heated in contact with charcoal, but air excluded, the iron will absorb carbon from the charcoal which becomes chemically combined with the iron. The resulting product is entirely changed in structure and mechanical properties. The converted bars were made into piles, heated to welding heat, and hammered into bars and were known as shear steel. However carefully made, these bars were liable to be irregular in composition, and this lack of homogeneity brought about the introduction of crucible steel by Huntsman in the latter part of the 18th Century. He conceived the idea that if the bars could be melted and cast into ingots a homogeneous product would result. After many experiments he succeeded, and crucible steel came into existence. With the exception of the use of manganese introduced by Heath about 1830, the manufacture of crucible steel is carried out in Sheffield in much the same way as in Huntsman's time. It is still the method used for the finer varieties of cutting steels. Before Bessemer's invention engineers had to rely chiefly on wrought iron for structural purposes. Bessemer was an engineer interested in gunnery, and was started on the path which ultimately led to his famous invention by the search for a stronger material for his gun experiments. He knew that in the manufacture of wrought iron from cast or pig iron that oxygen played an important part in the elimination of the impurities of the cast iron, so he first tried the effect of air blown through molten cast iron, relying on the combustion of the impurities to supply the necessary heat to keep the whole molten without the aid of outside heat. The result exceeded expectations, for not only did the combustion of the silicon and carbon of the cast iron provide sufficient heat, but the metal at the end of the operation was actually hotter than at the start. Silicon, one of the chief constituents of cast iron, gives off on combustion to silica 7,830 Centigrade heat units or 14,094 B.T.U., and has this advantage over carbon in that the products of combustion being solid, the heat is retained in the converter and not carried away in the escaping gases. At this stage Bessemer showed his experiments to a friend, who persuaded him to publish the results, which he did in a paper before the British Association at the Cheltenham meeting in 1856. The title of the paper was, "The Manufacture of Malleable Iron without Fuel." The paper created only a mild sensation, and was received by the trade generally rather with incredulity and a certain amount of ridicule, while the British Association thought so little of it that they did not include it in the copy of their proceedings. Nothing daunted, Bessemer and several friends established works at Sheffield to develop the process on a practical scale. Right at the outset Bessemer struck two very serious difficulties. In the puddling process for

making wrought iron the phosphorus in the cast iron is eliminated, and Bessemer quite expected the same would be the case in his process, but found there was no elimination of phosphorus at all. The reason is simple. In the puddling process the slags are basic, rich in oxide of iron, which easily carries off the phosphorus as phosphate of iron. In Bessemer's process there is an excess of silica produced by the oxidation of the silicon of the cast iron, and also derived from the lining of the converter, which was composed of ganister containing over 90 per cent. silica. Thus any base present in the converter charge was all absorbed by the excess of silica, and so no base was available for the absorption of the phosphorus. Fortunately for Bessemer's hopes there was in England, in the Cumberland district, a very fine deposit of hematite ore sufficiently low in phosphorus to produce a pig iron suitable for his process. Thus this difficulty was overcome. Another difficulty was much more serious, and at one time looked as if it would wreck the process. After a charge is completely blown in the converter, the resulting "blown" metal is practically pure iron, and naturally it was expected it would roll as easily as wrought iron; but when the ingots were put through the rolls they cracked and crumbled and behaved exactly like burnt or overheated iron. The cause of the trouble was oxide of iron, probably in a finely divided state, throughout the mass of the ingot. In the midst of their troubles and anxieties over this problem they received most encouraging news from Sweden, where with Swedish pig iron high in manganese excellent results were being obtained. Finally, Mushet patented the addition of manganese to the molten "blown" charge, and this solved the difficulty. Manganese having a strong affinity for oxygen, carried off the oxygen combined with the iron, and passed off in the slag, and so rid the metal of its red-shortness. The manganese had still a further effect, as it also combined with the sulphur present. Sulphur as sulphide of iron has also a red-short effect on the material, but sulphide of magnanese has not. There was a third benefit from the addition of manganese, for by adding it in the form of spiegeleisen, a cast iron containing 10 to 30 per cent. manganese and 5½ per cent. carbon, sufficient carbon was added to produce the various grades of structural steel required.

Thus was structural steel born, and it is impossible to estimate the enormous benefit it has conferred on engineering and world communications. In steel rails alone there was quite a revolution in railway progress and development. It would be impossible to run the heavy locomotives of to-day on iron rails, as they would prove too soft to stand the severe demands of modern railway requirements. Not only could they be made cheaper than iron rails, but the output of a single Bessemer converter as compared with the old puddling process was enormous. In the puddling process it took 1½ hours to make 4½ cwt. of wrought iron, whereas the Bessemer converter turned out 10 tons of steel ingots in 20 minutes. In America a pair of converters produced the record output of 2,000 short tons of ingots in 24 hours. The Bessemer process has seen its best days, however, and must give way to the more reliable open hearth steel process. It still survives in the use of small converters for the manufacture of steel castings and also as a preliminary purifier in what is known as the duplex process.

The next development was the invention of the Siemens regenerative steel furnace. With this furnace, Martin, in France, developed a method of steel making which was known as the Siemens Martin open hearth process. It was called open hearth because by means of doors in the sides of the furnace the charge was accessible for inspection and sampling. Martin melted pig iron and scrap on the hearth of the Siemens furnace, and added pure rich iron ore to refine the charge. Being accessible to inspection and sampling, the charge could be watched throughout the refining process, and by rapid chemical analysis was under perfect control. So reliable was the product that Lloyds adopted the Siemens open hearth process for all structural steel for shipbuilding, such as ship plates, boiler plates, beams, angles, etc. As the hearth of the furnace was made of silica sand, there was no elimination of phosphorus, and therefore pig iron low in that element had to be used, and also the quality of the steel scrap had to be known. Naturally iron and steel metallurgists turned their attention to the problem of de-phosphorisation in the Bessemer converter. In 1878 Thomas and Gilchrist, two Royal School of Mines men, patented hard burnt dolomite as a lining for Bessemer converters. This material mixed with tar and rammed in position with hot rammers solved the problem as regards a suitable lining of basic character. Messrs. Bolchow, Vaughan &

Co. had just completed a new Bessemer plant at Eston, near Middlesbrough, and under the management of Mr. Windsor Richards undertook the experiments. Middlesbrough pig iron containing 1½ per cent. phosphorus was used. The converter was lined with the hard burnt dolomite mixture, lime was added to the converter charge, and the blowing conducted exactly as in the ordinary Bessemer process. As soon as the carbon had gone blowing was stopped, and all expected to find the phosphorus eliminated. To their surprise and dismay practically all the phosphorus remained in the steel. They tried again and again, and nearly gave up in despair, when Mr. J. E. Stead (now the immediate past President of the Iron and Steel Institute) suggested going on blowing longer. No Bessemer man would have done this, because it had become a fixed rule in Bessemer practice that the blowing must be stopped as soon as the carbon had gone, otherwise the iron would be wasted and so charged with oxide as to be past redemption. The suggestion was tried, and in the extra two to three minutes out came the phosphorus, and the problem was solved. The nit was found that it was as easy to eliminate 2½ per cent. phosphorus as 1½ per cent. ,and that the higher phosphorus was necessary to take the place of silicon as a heat producer. The slag produced in the converter when using pig iron with 2½ per cent. phosphorus contained 18 per cent. phosphoric acid as phosphate of lime. One would scarcely expect that a phosphate of lime which had been submitted to a temperature of 1,600° C. or 2,914° F. would be any use as a fertiliser, but it proved on merely grinding to a fine powder and applied to the land without any other preparation to be a useful manure, and so became a valuable bye-product. Its composition is a tetra basic phosphate of lime. The successful solution of the de-phosphorisation problem in the converter had a wonderful result as regards the development of Germany's iron resources. As that country had no ores low enough in phosphorus for the ordinary Bessemer process (henceforth known as the acid process) and was too far away from low phosphorus ore deposits in other countries, she was practically cut off from the benefits of the Bessemer process, but as soon as the basic process proved a success she hastened to take advantage of it. By this process she was able to develop her resources, and did so to such an extent that Great Britain was soon overhauled in steel output and left well behind. Germany took second place in the world's output of steel, America being first and Great Britain third. Even in 1913, when the open hearth process had made such rapid strides, Germany still relied on the basic Bessemer for the greater part of her structural steel output. Her total output in that year was 1,8355,000: basic Bessemer, 10,600,000; basic open hearth, 7,330,000; acid Bessemer, 155,000; acid open hearth, 270,000.

The successful solution of making steel from pig iron high in phosphorus advanced the manufacture of structural steel considerably, but there was urgent need for still further development. Iron ores sufficiently low in phosphorus for the acid Bessemer and acid open hearth processes are not very plentiful. Again ores sufficiently high in that element for the basic Bessemer process are also not extensive. But all over the world there are huge deposits too high in phosphorus for the acid processes and too low for the basic Bessemer. To utilise these for steel making required some kind of basic process, which was eventually found by making the open hearth a basic one. The furnace is similar to that used for the acid open hearth, except that the hearth is made of hard burnt dolomite and magnesite instead of sand, and lime is added to the charge to form a basic slag. This process has now been so perfected that it has become easily the premier process in the manufacture of structural steel. It is under the same control as the acid open hearth process, and can in reason utilise almost any kind of pig iron and scrap. Lloyds, who would not look at basic Bessemer steel, and for a long time debarred basic open hearth, now accept the latter steel for ship building requirements. But for the successful establishment of the basic open hearth process structural steel could not have been manufactured in Australia, as the ores of that country are not suited or any other process. South Africa will also have to depend largely on this process, because her ores are in the majority of cases similar to the Australian. In 1905 Great Britain made 3½ million tons of acid open hearth steel. In 1913 the figures were: acid open hearth, 3,500,000 tons; basic, 2,800,000 tons. Since then the latter has grown further, all

the new steel works being practically basic open hearth. In America, in 1905, basic open hearth steel was 7 millions, in 1913 21 millions. In Canada during the war 60 per cent. of the shell steel produced was basic open hearth. Naturally this is only a brief summary of such a huge subject, but before closing, reference should be made to the wonderful assistance science has rendered in the development of the industry. For years it was carried on without any scientific knowledge of what was being done, but now the successful manufacture of structural steel could not be accomplished unless carried out on strictly scientific lines. Steel is made daily in large quantities of any desired composition with a confidence that is marvellous when the difference between the raw materials and the product aimed at is considered.

Now that the South African Government has passed a Bounty Bill to assist in the establishment of the iron and steel industry, it is to be hoped that those responsible will be up and doing, and establish the industry as quickly as possible. We can look forward to the time when all South African requirements of structural steel will be made here, and the surplus sent to less favoured countries. We can also look forward to the time when, before this Society, we shall be having papers on iron and steel problems in general and in South Africa in particular.

* *The Journal of the Chemical, Metallurgical and Mining Society of South Africa*, September, 1922.

ISOPROPYLSTANNONIC ACID.

By J. G. F. Druce.

*iso*Propylstannonic acid, prepared in a similar manner to ethylstannonic acid (*Trans. Chem. Soc.*, 1921, CXIX, 758), by the interaction of *iso*propyl iodide and potassium hydrogen stannite in accordance with the equation,

$$C_3H_7I + KHSnO_2 = C_3H_7:SnO:OH + KI$$

is amphoteric, forming salts with bases (most of which are basic) and dissolving in hydrochloric or hydrobromic acid to give the tin *iso*propyl trihaloid.

By boiling with excess of alkali- hydroxide solution, the acid is converted into di*iso*propylstannic oxide:

$$2C_3H_7\cdot SnO\cdot OK = (C_3H_7)_2SnO + K_2SnO_3.$$

This reaction recalls the mode of formation of ketones, with which this oxide is

resemblance in physical and chemical properties. When treated with hydrochloric or hydrobromic acid, it yields the corresponding dihaloid.

The di- and tri-haloid derivatives, $(C_3H_7)_2SnX_2$ and $C_3H_7\cdot SnX_3$, yield double salts with the halogen salts of pyridine. These substances have properties similar to those of the organic stannichlorides (*T.*, 1918, CXIII., 715).

Experimental.

*iso*Propylstannonic Acid, $C_3H_7\cdot SnO\cdot OH$.—The potassium hydrogen stannite solution required was made by adding a sufficient quantity (about 250 cc.) of 10 per cent. potassium hydroxide to produce a clear solution with 20 grams of stannous chloride, shaken with 60 cc. of water. *iso*Propyl iodide (22 grams) was then added, and the mixture was shaken at intervals during ten days. When the *iso*propyl iodide had disappeared, the solution was treated with dilute hydrochloric acid until neutral, the gelatinous precipitate of *iso*propylstannonic acid filtered, washed with warm water, and dried on a porous plate.

The *iso*propylstannonic acid was an almost white, amorphous substance, which did not melt, but decomposed when strongly heated, leaving a residue of stannic oxide. The acid was anhydrous, and did not gain in weight on exposure to the air. When heated out of contact with the air, it decomposed, giving off *iso*propyl alcohol, propylene, and a trace of propane. The residue contained stannous and stannic oxides and also a little carbonaceous matter.

The acid was insoluble in water and organic solvents, but dissolved in dilute mineral acids and in sodium or potassium hydroxide.

The *potassium* salt, $C_3H_7\cdot SnO\cdot OK$, was prepared by digesting excess of the acid (5 grams) with 40 cc. of 10 per cent. potassium hydroxide for several hours on a warm water-bath. After filtration the solution was kept in a desiccator over sulphuric acid until colourless, deliquescent, tabular crystals separated. These were washed with alcohol, drained, and dried between filter-paper. The salt dissolved readily in water, forming a very alkaline solution which became cloudy on keeping and on warming, owing to hydrolysis. With excess of alkali, the solution remained clear.

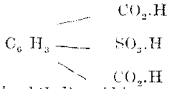
The *sodium* salt was isolated in the same way as the potassium salt, which it resembled in its properties

Basic calcium, strontium, and barium salts were obtained as white precipitates by adding excess of a solution of sodium or potassium *iso*propylstannonate to solutions of the metal chlorides. On analysis, the products were found to contain excess of the alkaline earth metal, and less tin, hydrogen, and carbon than the normal salt, $(C_3H_7SnO_2)_2M$, would require. Other basic salts of little interest were also obtained.—(From the *Transactions of the Chemical Society*, 1922, CXXI., 1859-60.)

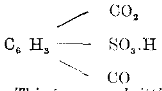
THE SULPHOPHTHALIC ACIDS AND THEIR SALTS.

By John Missenden.

This organic group consists of four known acids, two of which are isomeric. The ordinary sulphophthalic acid is the first in importance, and is the one having the two isomeric forms; the α-compound (1 : 4 : 2) and the *v*-compound (1 : 3 : 2), both of which may be said to have the following constitution:



a-Sulphophthalic acid is a crystalline substance, drying out into a mass consisting of sharp needles, each crystal containing precisely one molecule of water which may be driven off by heating the body to a temperature of 148° C., leaving a viscid liquid in place. This liquid will solidify upon standing. If the temperature be further raised until it reaches 167° C., the anhydride



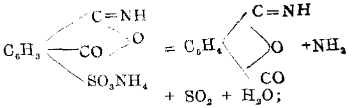
is formed. This is a very brittle substance, possessing a brownish tinge. There are several methods of producing α-sulphophthalic acid, but two will suffice for all practical purposes. The first method was discovered by Gräbe,[1] and takes the form of oxidizing a mixture of dinitronaphthisulphonic acid, $C_{10}H_4(NO_2)_2$, and β-naphthalene-sulphamide, $C_{10}H_7SO_2.NH_2$. The second method[2] is to heat a mixture of concentrated sulphuric and phthalic acid, $C_6H_4.2(CO_2H)$, the α-sulphophthalic acid remaining as a viscid substance until the superfluous moisture has been evaporated. It is soluble in water.

The second acid is the *v-sulphophthalic acid*, and is produced when a mixture of potassium permanganate and α-naphthalenesulphamide is subjected to oxidation. It is soluble in water.

Normal barium α-sulphophthalate, when mixed with a large excess of hydrochloric acid, is converted into the di-acid salt, $Ba[C_6H_3(CO_2.H)_2SO_3]_2.5H_2O$, a crystalline substance of the acute pyramid order. The ratio of hydrochloric acid to the normal salt for the production of the monacid salt is as 3 : 2. The monacid salt $C_6H_3(CO_2BaSO_3).CO_2H.2H_2O$, is also a crystalline body of the same order.

Normal barium v-sulphophthalate, $Ba.[C_6H_3(CO_2)_2.BaSO_3]_2.8H_2O$, is a tabular crystalline substance, possessing similar properties to the normal α-salt.

Ammonium α-sulphophthalimide is produced when the *monacid ammonium α-sulphophthalate* is subjected to heat. This substance decomposes, if too high a temperature be attained, as follows:—



the compound first formulated on the right hand side of the equation being phthalimide.

The third, *sulphinidephthalic acid*, $C_8H_5NSO_3.2H_2O$, is dibasic, the replacement with a metal of the imide-hydrogen group being a simple reaction. It is not converted into sulphamicphthalic acid by the action of alkalis,[3] and becomes anhydrous at 162°. Normally it is crystalline, and forms, in most cases, crystalline salts, of which there is a large variety. These salts take two forms—normal and acid—which differ somewhat in their properties.

Of the normal salts, *normal methyl sulphinidephthalate*, $C_8H_3NSO_3.(CH_3)_2$, is a colourless substance of the acute pyramid

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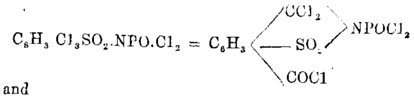
[1] *Ber. Deut. Chem. Ges;* XVIII., 1126

[2] *Ann. Chem. Pharm.;* CCXXXIII., 216.

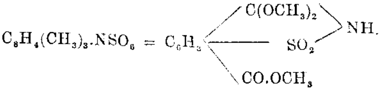
[3] *See α-sulphamidophthalic acid, ut inf.*

order. It is insoluble in water, but soluble in alcohol, and melts at 173° C. It is capable of sublimation. *Normal potassium sulphinidephthalate*, $C_8H_3NSO_5K_2$, is a semi-crystalline body, consisting of a number of opaque spheres. It is soluble in water. *Normal silver sulphinidephthalate*, $C_8H_3NSO_5.Ag_2.H_2O$, is a white powder, which is soluble in a hot potassium nitrate solution, but almost insoluble in boiling water.

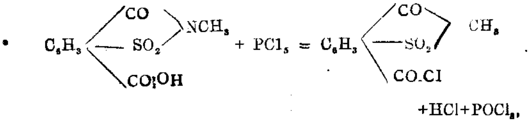
Acid methyl sulphinidephthalate, $C_8H_4NSO_5.(CH_3)$, is a highly volatile, crystalline body, which takes the form of tablets, or acute, streaked prisms. Its melting point is 192.3° C. In order to produce the dimethyl ether, it is treated with methyl alcohol and phosphorus trichloride. *Acid potassium sulphinidephthalate*, $C_8H_4NSO_5.K.H_2O$, also takes the form of acute prisms, which become anhydrous at 103° C. This acid salt was used to determine the general constitution of the acid sulphinidephthalates.[4] It was mixed with phosphorus pentachloride, and the two were heated, this resulting in the formation of the compound $C_8H_3.Cl_3SO_2.NPO.Cl_2$, which is a crystalline body consisting of minute prisms. It was converted by methyl alcohol into the trimethyl ether, $C_8H_4(CH_3)_3.NSO_6$, which is also crystalline with a melting point of 141° C. The constitution of these two compounds is as follows:—



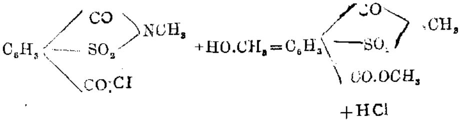
and



Hence, since the methyl alcohol and the phosphorus pentachloride were responsible for the monomethyl ether and the diethyl ether respectively,[5] it will be seen that in the latter case (*i.e.*, that of the diethyl ether), which also bears upon the acid sulphinidephthalates, the imido-hydrogen is replaced in accordance with the following equation:—



and, disregarding entirely the produced hydrochloric acid and phosphorus oxytrichloride, the final equation is:—



[4] *Roscoe and Schorlemmer.*

[5] *Stokes.*

The last of this group, a-sulphamidophthalic acid, $C_6H_3(NH_2SO_3).2(CO_2H)$, is not of such great importance. When it is treated with phosphorus pentachloride and the mixture is allowed to stand, the monochloride, $C_6H_3(Cl.SO_2).2(CO_2H)$, is produced. This may be transformed into the amide by the action of ammonia.

Acid potassium sulphinidephthalate is more soluble in hot water than it is in cold. *Acid silver sulphinidephthalate*, C_8H_4-$NSO_3.Ag.H_2O$, is likewise crystalline, of the acute pyramid order, which loses its water at 131.5° C. It may be produced by adding silver nitrate to a boiling solution of acid potassium sulphinidephthalate, the crystals appearing as the mixture cools.

PROCEEDINGS OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, NOVEMBER 23, 1922, AT 4 P.M.

A Special General Meeting was held to consider the annual report of Council.

AT 4.30 P.M.

Papers read:—

DR. T. E. STANTON, F.R.S.: *On the Characteristics of Cylindrical Journal Lubrication at High Values of the Eccentricity.*

J. H. JEANS, SEC. R.S.: *The Propagation of Earthquake Waves.*

PROF. F. A. LINDEMANN, F.R.S., and G. M. B. DOBSON: *A Theory of Meteors and the Density and Temperature of the Outer Atmosphere to which it leads.*

PROF. F. C. THOMPSON and E. WHITEHEAD: *On the Changes in Iron and Steel at Temperatures below 280° C.* Communicated by Prof. H. C. H. Carpenter, F.R.S.

C. F. JENKIN: *The Fatigue Failure of Metals.* Communicated by Sir Alfred Ewing, F.R.S.

S. BRODETSKY: *The Line of Action of the Resultant Pressure in Discontinuous Fluid Motion.* Communicated by Sir George Greenhill, F.R.S.

DR. R. A. HOUSTOUN: *An Investigation of the Colour Vision of 527 Students by the Rayleigh Test.* Communicated by Prof. A. Gray, F.R.S.

ORDINARY MEETING, NOVEMBER 16, 1922.
Sir Charles Sherrington, President, in the Chair.

The following papers were read, the summaries here printed having been supplied by the Authors for use at the meeting:—

PROF. A. S. EDDINGTON, F.R.S.: *The Propagation of Gravitational Waves.*

The potentials given in Einstein's theory represent not only the absolute gravitational disturbance of the field, but also the metric of the co-ordinate system which is to a great extent arbitrary; consequently the speed of propagation of the potentials is not necessarily the speed of the absolute disturbance. Einstein showed that, when the co-ordinate frame is chosen subject to a certain restriction, the potentials are propagated with the speed of light.

The present paper considers the propagation of plane waves on unrestricted co-ordinates; and it is found that "transverse-transverse" waves continue to have the speed of light, whereas the other two types ofwave s have no fixed speed when Einstein's restriction is removed. It is shown that the latter types do not correspond to any absolute disturbance of the field. Of the three conceivable types of transverse-transverse waves, one is inconsistent with the equations of entirely empty space, $G_{\mu\nu} = o$; but this type nevertheless commonly occurs in nature, viz., as a propagation of gravitational disturbance by light-waves.

Divergent waves are also considered. It is pointed out that, although the equations correspond to those of sound-propagation, no uniform spherical waves of gravitation can occur; they must always be complicated by doublet-sources for some of the components. The waves emanating from a spinning rod are worked out in detail, and it is found that (in agreement with Einstein) the rod must slowly lose energy by these waves; for a typical example the period of decay of the rotation is found to be of the order 10^{35} years.

J. H. JEANS, D.Sc., SEC. R.S.: *The Theory of the Scattering of α- and β-Rays.*

A theory of scattering is developed in which both the feeble encounters of the theory of multiple scattering and also the violent encounters of the theory of single scattering are duly taken into account. It had been hoped that the investigation would disclose some method by which the influence of multiple scattering could be disentangled from observational material, leaving single scattering free for further study, but it has not done so. It is found that the presence of single scattering produces very nearly the same effect as can

be produced by a suitable adjustment of the constants in the law of multiple scattering, and this renders the problem of the separate study of single scattering one of great difficulty experimentally.

PROF. A. P. CHATTOCK, F.R.S., and L. F. BATES: *On the Richardson Gyromagnetic Effect.*

Richardson has shown that the angular momentum arising in a ferro-magnetic substance from unit change in its magnetic moment should have the value of 1.13×10^{-7} if gyrating electrons are responsible for its magnetism. Measurements of this quantity by the ballistic method for three specimens of iron and one of nickel are given in the paper. The results, divided by 1.13×10^{-7}, are collected in the following table under "Ratio":—

Specimen.	Ratio.
Iron	0.507
,,	0.501
,,	0.500
Nickel	0.505

They agree to within $1\frac{1}{2}$ per cent. with one another, and their mean is 0.6 per cent. greater than 0.500. Close proportionality is also shown to exist between the change of magnetic moment and the angular momentum resulting.

The specimen experimented upon consisted of an upright wire suspended by a quartz fibre. By the introduction of a hinged joint between wire and fibre the important adjustment of the magnetic axis of the wire to the vertical is so much facilitated that measurements were found to be practicable on reversal of magnetism instead of on merely reducing it to zero. The more perfect symmetry resulting from this procedure may be the cause of the more consistent results obtained.

The effect on the ratio of the eddy currents set up in the specimen by its changing magnetism was examined and shown to be not more than a small fraction of 1 per cent. for the specimens used. At high dampings the ordinary damping correction was found to give values that were too large; the error being more noticeable for small than for large amounts of inertia. The effect of this on the measured ratio is shown to be eliminated.

P. M. S. BLACKETT: *On the Analysis of α-Ray Photographs.* Communicated by Sir Ernest Rutherford, F.R.S.

The work commenced by Shimizu of studying the passage of α-rays through gases, by means of Mr. C. T. R. Wilson's expansion method, was continued. A large number of photographs were taken of the ends of the tracks of α-rays from Polonium in both air and argon. Attention was especially directed to the sudden bends made by the tracks due to collision with the atomic nuclei, and the actual form of these bends was obtained from measurements of the double images given by the special camera designed for the work by Shimizu.

Methods were developed for utilising the data so obtained which related to the frequency of occurrence of bends of given type, and as a result of the calculations the observations were found consistent with the existence of an inverse-square law of force between the α-particles and the nuclei, when their distance apart lies between 6×10^{-12} and 10^{-9} cms. for argon, and 3×10^{-12} and 5×10^{-10} cms. for air.

The velocity of the α-particles along the latter part of their tracks was also calculated from the frequency of the bends and found to be much lower than had been expected. Velocities as low as 10 cms. per second were obtained, and the relation connecting the velocity v and the range r was found to be roughly of the form $v \propto 2^{\frac{2}{5}}$ instead of the form $v \propto 2^{\frac{1}{3}}$ found by Marsden and Taylor for the early part of tracks by other methods. No anomalous effects were discovered as regards frequency or type of collision, as had been suggested by Shimizu.

J. H. JONES: *The Kinetic Energy of Electrons Emitted from a Hot Tungsten Filament.* Communicated by Prof. O. W. Richardson, F.R.S.

This paper deals with distribution of energy among emitted electrons. When allowance is made for experimental and secondary effects the distribution of energy is found to agree with that given by Maxwell's law.

Of experimental errors the most serious are probably due to difficulties of measuring small currents involved and accurate temperatures. These lead to uncertainties which in individual experiments may amount to as much as 10 per cent.

The secondary effects probably arise from contamination of the heated surfaces. This tends to increase apparent energy of electrons emitted and the increase may amount to as much as 20 per cent. In these cases the filament is emitting inefficiently and currents are difficult to saturate.

The abnormal electron energies found by Ting, which were as much as 100 per cent. in excess of the Maxwell distribution value, do not appear under satisfactory experimental conditions.

W. WILSON, D.Sc.: *The Quantum Theory and Electromagnetic Phenomena.* Communicated by Prof. J. W. Nicholson, F.R.S.

From the point of view of the quantum theory such systems as atoms possess stationary states which are subject to conditions expressed by the equations—

$$\int p_s dq^{(s)} = n_s h.$$

The paper is chiefly concerned with an extended form of these quantum restrictions in which the momenta, p_s, are replaced by more general momenta, π_s, involving the components of the vector potential of the external field to which the system is subjected.

S. MARSH and A. E. EVANS: *On Measurements of Electrode Potential Drop with Direct Current and Alternating Current Electrolysis.* Communicated by Dr. E. H. Griffiths, F.R.S.

Electrodes of polished platinum, platinum-black, gold and nickel were used, normal sulphuric acid serving as the electrolyte. With direct current, anodic and cathodic effects were examined; with alternating current, the frequencies ranged from 25 to 80. Experiments were also made with various current densities. With all the metals examined, the cathodic drop increases with time, the curves (especially with polished platinum) resembling saturation curves in radio-activity. The anodic drop decreases at first and then rises similarly to the cathodic curve. With alternating current the electrode drop decreases during an interval depending on the frequenyc and thereafter increases slightly.

It is suggested that the cathodic curves represent the effect of occlusion, while the anode curves represent the opposing effects of oxidation and occlusion. An explanation of the effects with alternating current follows on these lines.

ROYAL SOCIETY OF ARTS.

JOHN STREET, ADELPHI.
169th Session, 1922-1923.

Arrangements for meetings during December, 1922.

Monday, December 4th, 8 p.m. (Cantor Lecture): WILLIAM ARTHUR BONE, D.Sc., PH.D., F.R.S., Professor of Chemical Technology, Imperial College of Science and Technology, "*Brown Coal and Lignites.*" (Lecture 2.)

Tuesday, December 5th, 4.30 p.m. (Dominions and Colonies Section): MAJOR OWEN RUTTER, F.R.G.S., F.R.A.I., "*British North Borneo.*" (With cinematograph illustrations.) Edward Dent, M.A., Member of the Council of the Society, will preside.

Wednesday, December 6th, 8 p.m. (Ordinary Meeting): H. EMORY CHUBB, "*Recent Developments in the Manufacture of Safes and Strong Rooms.*" (With cinematograph illustrations.) Laurence Currie, M.A., J.P., will preside.

Monday, December 11th, 8 p.m. (Cantor Lecture): WILLIAM ARTHUR BONE, D.Sc., PH.D., F.R.S., Professor of Chemical Technology, Imperial College of Science and Technology, "*Brown Coal and Lignites.*" (Lecture 3.)

Wednesday, December 13th, 8 p.m. (Ordinary Meeting): SIR SIDNEY F. HARMER, K.B.E., Sc.D., F.R.S., Director of the British Museum of Natural History, "*The Fading of Museum Specimens.*" The Earl of Crawford and Balcarres, K.T., P.C., F.S.A., will preside.

Friday, December 15th, 4.30 p.m. (Indian Section): COMMISSIONER F. DE L. BOOTH TUCKER, "*The Settlements of Criminal Tribes in India.*" Sir Edward R. Henry, Bt., G.C.V.O., K.C.B., Inspector-General of Police, Bengal, 1891; Commissioner of Police in the Metropolis, 1903-8, will preside.

THE OPTICAL SOCIETY.

A meeting of the Optical Society was held at the Imperial College, Imperial Institute Road, South Kensington, on Thursday, 30th November, 1922, when there was a discussion on subjects relating to spectacles and spectacle construction.

The meeting commenced at 6 p.m., and there was an interval from 8 to 8.30 p.m., during which light refreshments were served.

The following papers were read:—

"*The design of Spectacle Lenses,*" by A. WHITWELL, M.A.

"*Some Recent Developments in Spectacle Lenses,*" by W. A. DIXEY.

"*On the Available Means for Correcting Considerable Cases of Anisometropia,*" by DR. M. VON ROHR.

"*The Best Form of Spectacle Lenses for the Correction of Small Amounts of Anisometropia,*" by A. WHITWELL, M.A.

"*Notes on the Non-Operative Treatment of Squint,*" by DR. M. B. DOBSON.

"*Sir William Crooke's Anti-Glare Glasses,*" by JAMES H. GARDINER, F.INST.P.

"*Standards of Accuracy or Ophthalmic Prescriptions,*" by O. RAPHAEL.

"*Methods used in the Manufacture of Gold-filled Spectacles and Clips,*" by A. S. RYLAND.

In connection with the meeting, an exhibition of frames, lenses, and all apparatus connected with spectacle fitting and construction was held from 3 p.m. till 8 p.m. Exhibits and demonstrations were given by the leading firms in the industry.

THE GEOLOGICAL SOCIETY OF LONDON.

NOVEMBER 8TH, 1922.

Professor A. C. Seward, F.R.S., President, in the Chair.

The following communications were read:—

"*The Earthquake of 7th August, 1895, in Northern Italy,*" by RICHARD DIXON OLDHAM, F.R.S., F.G.S.

"*The Pamir Earthquake of 18th February, 1911,*" by RICHARD DIXON OLDHAM, F.R.S., F.G.S.

"*The Geology of Sierra Leone,*" by FRANK DIXEY, D.Sc., F.G.S. (Read by Dr. H. H. Thomas, M.A., V.P.G.S.)

A meeting of the Society was held on Wednesday, November 22nd, 1922, when Prof. A. S. Eddington, M.A., F.R.S., delivered a lecture on "The Borderland of Astronomy and Geology."

SOME NEW LECTURE EXPERIMENTS WITH HYDRONITRIC ACIDS AND THE TRINITRIDES.[1]

By A. W. BROWNE AND A. B. HOEL.

[CONTRIBUTION FROM THE DEPARTMENT OF CHEMISTRY OF CORNELL UNIVERSITY.]

For the purpose of demonstrating certain of the chemical properties of hydronitric acid and the trinitrides, a number of experiments suitable for use on the lecture table have been devised. These have been tested repeatedly by actual use in lectures given by one of the authors at this University and elsewhere.

1. *Nitridation of Hydriodic Acid by Means of Hydronitric Acid.*—This experiment illustrates the similarity between hydronitric acid (hydrogen pernitride) and hydrogen peroxide.

Five cc. of conc. hydriodic acid (sp. gr. 1.5) are poured into a 15cm. test-tube, avoiding stirring to minimise oxidation, and 1 cc. of a 1 per cent. solution of hydronitric acid is added, whereupon iodine is liberated and nitrogen is evolved. The presence of the iodine is demonstrated by pouring part or all of the mixture into 2.5 litres of water containing starch solution. The reactions may be represented by the following equations: $2HI + HN_3 = NH_3 + N_2 + 2I$; $HI + NH_3 = NH_4I$; and are analogous to those between hydriodic acid and hydrogen peroxide. Nitrous and nitric acids lie between hydrogen peroxide and hydrogen pernitride in composition and character. A blank experiment, in which either water alone or hydrochloric acid is used in place of the hydronitric acid, will prove that the liberation of iodine is really due to the action of the nitridizing agent.

2. *Nitridation of Hydrochloric Acid by Means of Hydronitric Acid.*—While it is scarcely surprising that so powerful a reducing agent as hydriodic acid should evoke the nitridizing power of hydrochloric acid, it is noteworthy that so stable a compound as hydrochloric acid should undergo nitridation with liberation of chlorine. Turrentine[2] has already shown that hydrochloric acid in presence of hydronitric acid will dissolve platinum.

Five cc. of conc. hydrochloric acid is treated with 1 cc. of a 1 per cent. solution of hydronitric acid in a 15 cm. test-tube, and is heated to the boiling point and held at this temperature for at least 1 minute. This length of time is usually required to effect appreciable nitridation, but excessive boiling may result in loss of the free chlorine. Evidence of the liberation of chlorine is obtained by pouring the contents of the test-tube, either immediately, or after cooling to room temperature, into 2.5 litres of water containing starch and potassium iodide. When water is used in place of

[1] *The investigation upon which this article is based was supported by a grant from the Heckscher Foundation for the Advancement of Research, established by August Heckscher at Cornell University. The present paper is Article No. 2 under Heckscher Grant No. 4. For Article No. 1 see Journal of the American Chemical Society,* 1922, XLIV., 2106.

[2] *Turrentine, Jour. Amer. Chem. Soc.,* 1912, XXXIV., 385-387.

the hydronitric acid, in a blank experiment, the result is negative. The following equations express the reactions involved: $2HCl + HN_3 = NH_3 + N_2 + 2Cl$; $HCl + NH_3 = NH_4Cl$.

The formation of ammonia as a reaction product in Expt. 1 or 2 may be demonstrated by mixing either hydriodic or hydrochloric with hydronitric acid, as just described, adding sodium hydroxide in excess and testing for ammonia with litmus paper or, after distillation, with Nessler's solution.

3. *Formation of Potassium Manganate by the Action of Potassium Trinitride upon Manganese Dioxide.*—The similarity which exists between pernitrides and peroxides of the alkali metals may be illustrated by the conversion of manganese dioxide into potassium manganate which takes place when the dioxide is heated with potassium trinitride (pernitride) in presence of air.

Samples of finely pulverized potassium trinitride and manganese dioxide, weighing 0.5 gr. each are mixed very thoroughly on glazed paper, and the mixture is gently heated in a 100 cc. porcelain crucible, over a low flame, so adjusted a sto cause the reaction to take place in from 30 to 60 seconds. During this process the operator should take care not to stand too near the crucible, as the reaction proceeds with considerable violence, accompanied by a hissing noise and by the emission of numerous sparks.

To minimise loss of the reacting material a 200 cc. crucible may be inverted over the 100 cc. crucible before heat is applied, but the smaller crucible should be heated for a few minutes after the reaction has occurred and the larger crucible has been removed, in order to permit the second stage of the process, which results in formation of the manganate, to take place.

In either event, the crucible containing ing the dark green product is allowed to cool to room temperature, and the contents are treated with about 25 cc. of water. After solution has taken place, the resulting liquid is poured into 2.5 litres of water. The deep green colour soon changes, on standing, to that of a permanganate solution, especially if a small amount of dilute sulphuric acid be added.

The main reaction involved in this experiment takes place in three stages: first, decompostiion of the potassium trinitride into its elements; second, reduction of the manganese dioxide by the action of metallic potassium, with formation of manganous oxide and potassium oxide, or possibly of potassium hypomanganite; third, oxidation of the hypomanganite to potassium manganate by means of atmospheric oxygen. These three stages may be expressed by the equations: $2KN_3 = 2K + 3N_2$; $MnO_2 + 2K = K_2O.MnO$; $K_2O.MnO + O_2 = K_2MnO_4$.

In the early work on the subject conducted in this Laboratory[3] traces, only, of ammonia were detected in the product obtained. Later experiments have shown that considerable quantities of ammonia are formed under certain conditions. Immediately after the addition of a small quantity of water to the residual green product a strong odour of ammonia may be perceived, and the presence of this substance may be confirmed by the usual tests.

The presence of ammonia as a reaction product indicates that the process does not take place entirely in accordance with the equations given above, but that a part of the nitrogen of the potassium trinitride is fixed, probably as a product of nitridation, in the form of a potassium ammonomanganite or manganate, or of a compound that is essentially a mixed ammono-aquo-manganite or manganate.

4. *Detonation of Silver Trinitride with the Aid of a Fuse Composed of Paper Impregnated with Potassium Trinitride.*—A strip from 0.5 to 1.0 cm. wide and from 0.25 to 0.5 m. long, is painted on a large filter paper or paper towel with the aid of a small brush dipped in a 5 per cent. aqueous solution of potassium trinitride. While this is drying, a sample of silver trinitride is prepared by adding, in slight excess, drop by drop, a dilute solution of silver nitrate to 25 cc. of a 1 per cent. solution of hydronitric acid, diluted with an equal volume of water. The flocculent precipitate is collected upon a small filter, and is washed with successive small portions of cold water until the excess of the precipitant has been removed. While still moist, a quantity of the silver trinitride, about sufficient to cover an 18 mm. disc to a depth of 1 mm., is carefully pressed upon the filter paper or paper towel, on one end of the painted strip. If any difficulty is experienced in causing the explo-

[3] *Goldberg, Jour. Amer. Chem. Soc.*, 1912, XXXIV., 886.

sive to stick to the paper, a small amount of adhesive may be used, or the solid may be held in place by covering it with a thin piece of filter or tissue paper, glued around the edge. It is important that the paper beneath and around the explosive be treated wit ha liberal amount of the potassium trinitride solution. After both fuse and explosive have been thoroughly dried, the sheet is suspended from a suitable frame or moulding so that the air has free access to both sides o fthe paper. When the end of the fuse farthest from the silver trinitride is touched with a glowing splint or with a small flame, the combustion gradually progresses toward the explosive, which finally detonates with a sharp report. Interest in the experiment is considerahly enhanced if an appropriate crayon sketch is made upon the paper. For example, an explosive cap may be concealed in the figure of an airplane, while the lower end of the fuse is located at the muzzle of an anti-aircraft gun.

This experiment serves to illustrate (a) the highly explosive character of the heavy-metal trinitrides, which may in general be detonated either by heat or by mechanical impact, and (b) the similarity between potassium trinitride and potassium nitrate when employed in the manner suggested.

When potassium nitrate of corresponding concentration is used for the fuse, the combustion progresses with a velocity about double that noted when the trinitride is used. The paper evidently burns at the expense of the oxygen of the potassium nitrate. With the trinitride, the initial reaction is undoubtedl ythe exothermal decomposition of the substance into potassium and nitrogen, with subsequent combustion of the free metal, and incidentally of the paper, in the oxygen of the air. While these are the main reactions, it is probable that nitridation accompanies oxidation, at least to a limited extent, as is attested by the presence of ammonia in the products of the reaction.

SUMMARY.

The present article contains a brief descripiton of several new lecture experiments designed to illustrate

(1) nitridation of hydriodic acid by means of hydronitric acid (hydrogen pernitride);

(2) nitridation of hydrochloric acid by means of hydronitric acid;

(3) formation of potassium manganate by action of potassium trinitride (potassium pernitride) upon manganese dioxide;

(4) detonation of silver trinitride with the aid of a fuse composed of paper impregnated with potassium trinitride.

Ithaca, New York.

—*Journal of the American Chemical Society, October*, 1922.

THE FARADAY SOCIETY.

Papers read Monday, 20th November:—

Intramolecular Ionisation, by THOMAS MARTIN LOWRY.

The Scattering of Light by Organosols and Gels of Cellulose Acetate, by ERNEST WALTER JOHN MARDLES.

Viscosity Changes Associated with the Gel to Sol Transition, by ERNEST WALTER JOHN MARDLES.

On the Viscosity and Molecular Dimensions of Hydrogen Selenide, by C. J. SMITH, M.Sc., A.R.C.S., D.I.C., Research Student, Imperial College of Science and Technology.

The Hydrogen Concentration of Natural Waters and Some Etching Reagents in Relation to Action on Metals, by W. R. G. ATKINS, Sc.D., F.I.C.

NOTICES OF BOOKS.

Atomic Form, by EDWARD E. PRICE. Pp. 140 + VIII. London: Longmans, Green & Co., 39, *Paternoster Row*, E.C. 1922. Price 5s.

The author advances a Theory on Atomic Structure with special reference to the configuration of the carbon atom. He assumes that the carbon atom has a definite form, termed a "Carbonoid." The theory affords an explanation for the crystalline structure of Diamond and Graphite, and accounts for Tautomerism and for the existence of optical isomers.

The "carbonoid" itself is assumed to be an *irregular*- tetrahedron, and to its special configuration the asymmetry of the chain is due.

With regard to optical activity, it is claimed for the theory that the right and left-handed spirals are displayed by the "carbonoid" aggregates when representing carbon chains, resulting in an asymmetric arrangement like that of an object and its mirror-image.

A chapter is devoted to a possible and ingenious explanation of the polymerisation of isoprene into rubber.

It is difficult to grasp clearly the features of the Theory from drawings alone, resort to models would be more helpful. For this reason, and that discussion would be helpful, the author should consider the advisability of stating his views before a Scientific Society.

On page 15 it is erroneously stated that ethylene is the principal constituent of coal gas, but this does not detract from the value of the volume as a contribution towards the elucidation of the form of the carbon-atom.

Coal and Allied Subjects, by F. S. SINNATT, M.Sc. (TECH.), F.I.C.M.I.MIN.E., with the following collaborators: R. A. B., A. Grounds, B.Sc. (Tech.), A.I.C., H. Stern, B.Sc., A.I.C., F. Bayley, M.Sc. (Tech.), A.I.C., M. Barash, M.Sc. (Tech.), A.I.C., W. Harrison, F.C.S., A. McCulloch, A.I.C., May B. Craven, M.Sc. (Tech.), A.I.C. Pp. 205. London: H. F. & G. Witherby, 326, High Holborn, W.C. 1922. Price 15s.

This volume forms a compendium of the first ten bulletins issued by the Lancashire and Cheshire Coal Research Association, and its issue will enable others engaged in Coal Research to share the knowledge and experience gained by the author and his collaborators.

The first is based upon ten introductory lectures on organic chemistry, which are evidently intended for those interested in the study of coal.

The sections which follow deal with sampling, the influence of inert matter upon the yield of volatile products evolved when coal is destructively distilled; coal dust, fusain, etc.

Nearly 40 pages are devoted to the analysis of coal, and this constitutes a valuable portion of the compendium. The method adopted by the Association for determining the calorific value of coal is the subject of the last section.

This compendium contains, therefore, information of considerable value to those concerned with the scientific aspects of the coal industry.

New Patents.

THIS list is specially compiled for the *Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

cess of extracting sodiac salts from bi-carbonated mineral waters. Nov. 3.

29728—Chemical Eng. Co.—*Processes for producing* intimate mixtures of substances and obtaining chemical products therefrom.

Specifications Published this Week

187347—Wade, H.—Apparatus for making ether.

178375—Rushen, P. C.—Process for the reduction of metal oxides by means of aluminium in the furnace.

170861—Victoria Iron Rolling Co.—Treatment of tin-plate scrap.

172958—Sceib, G.—Process and apparatus for the manufacture of pure nitrogen-carbonic acid mixture from combustion gases.

187423—Sams, E. H.—Fertiliser and process of making same.

Abstract Published this Week.

Electrolysis.—Patent No. 185842.—A process for purifying and concentrating material containing tungsten or molybdenum by anodic oxidation, has been evolved by Mr. R. E. Pearson, of Duram Works, Nightingale Rd., Hanwell, London, and *Craig, N. E., Beaufort House, Ham Common*, Surrey.

If an acid electrolyte is used, the metallic im*purities go into solution*, leaving the tungstic or molybdic oxide or the metals; if an alkaline electrolyte is used the tungsten and molybdenum go into solution, leaving the impurities. In one example crude molybdenite is crushed to a fine powder and made into a paste with the electrolyte, which may consist of dilute sulphuric acid; it is supported on an anode plate and may be agitated from time to time. Iron and alumina go into solution, and the sulphide of molybdenum is converted into oxide; the molybdic oxide that remains may be separated from the silica gangue which remains by ammonia treatment. A voltmite, a 25 per cent. solution of caustic soda may age of 4-7 volts may be used. In treating wolfrabe used as electrolyte. The tungsten goes into solution as sodium tungstate, and ferrous and manganese oxides are converted into higher oxides which remain as a sludge on the anode plate. In treating impure tungsten powder obtained, for example, by reduction of the yellow *oxide with hydrogen, sulphuric acid of specific* gravity 1.2 is used as electrolyte. The paste is introduced into a porous pot in which an anode of platinum wire is inserted. The cathode is a stout rod of lead. A current of 5 amperes at 5 volts is used. The current density at the anode is kept low to prevent excessive oxidation of the tungsten. It is stated that soda crystallises out on the cathode. The contents of the anode pot may, after the reaction, be transferred to the cathode compartment of another cell, the cathode in this case being a group of nickel-chromium rods and the anode a rod of lead. Any tungsten oxidised during the anode reaction is reduced by this treatment, and arsenic and sulphur are removed; soluble silica passes into the solution. The contents of the cathode pot are washed and dried and reduced by hydrogen, and may then be compressed into bars and sintered. Oxalic acid may be used as electrolyte when sodium is the main impurity; hydrochloric acid when iron *is the main impurity, and sulphuric acid when* carbides are present; these electrolytes may be used successively. Specification 181,837 is referred to.

Messrs. Rayner & Co. will obtain printed copies of the published Specifications, and forward on post free for the official price of 1s. each.

THE CHEMICAL NEWS,

VOL. CXXV., No. 3269

SOUTH AFRICAN CHEMICAL INSTITUTE.*

Presidential Address.

George Hardy Stanley, A.R.S.M., F.I.C.

On this, the second occasion on which it has been my privilege to deliver to you a presidential address, it is fitting that I should commence by expressing the gratification I feel at the honour done me in again electing me President; and more especially because my year of office is the first of our existence as a Chemical Institute.

If that year will not be such a pleasant memory as the previous one, 1913-14, it is certainly not the fault of the Institute, but of the times and trials through which the whole community has passed; and, considering the conditions obtaining, we may well congratulate ourselves on showing a small advance in membership and assets when a retrogression could scarcely have occasioned surprise. We have, indeed, made steady progress from the commencement, and have trebled our membership since 1914.

The general financial stringency, and preoccupation with other affairs, has hampered us to a great extent during the past year; more, I think, than will he gathered from the Council's report, and among other things the Private Bill has had to be postponed till some way can be devised for lightening the financial burden involved. No douht, also, these factors have been responsible for the dearth of activity in connection with subjects for chemical research, in which direction not a single suggestion has so far been made.

We have now come to the end of the tenth year of our corporate existence, which seems to indicate this as an appropriate time at which to take stock of the position, not only of our profession, hut also of the industry with which many of us are directly associated, and all indirectly concerned. And if, in doing so, one finds it easy to he pessimistic, a glance at possibilities of future expansion may act as antidote. I have therefore selected as my subject,

"South African Chemical Industry and Its Future."

When I addressed you eight years ago I spoke in blissful ignorance of the proximity of the cataclysm which so shortly thereafter convulsed the world, and one point I endeavoured to emphasise was the general ignorance with regard to the nature of the chemist's calling. To-day there is no excuse for such a state of affairs. The prominence into which chemistry was brought *in connection with modern scientific warfare ought at least to have given it all the* advertisement required, and certainly great appreciation of the services of chemists was freely expressed.

But unfortunately the public is possessed of but a short memory, and already, as in other directions, forgetfulness is apparent, and there is danger that the utility of chemistry in the arts of peace, which seemed likely as a result of war to become more fully recognised, will not receive that recognition to which it is entitled. On the contrary, rule of thumb methods still prevail, and many industries which ought to employ chemists in connection with their operations still continue their penny-wise and pound-foolish policy.

In my opinions, there ought to be more chemists employed, or at least more chemical advice obtained than is at present the case, in connection with the manufacture of foodstuffs of all kinds, the clay industries, the leather industry, and paint manufacture, to mention only a few. This, of course, would largely increase the field of employment for chemists, whose profession at the present time may justly be regarded as overcrowded.

This, however, appears to be a world condition, and I have for the purpose of this address endeavoured to form an idea of what are the possibilities of expansion of the chemical industry in the Union, and hence of the chances of an increased demand for chemists. In Great Britain, the Institute of Chemistry has a total membership of about 4,500, which is equivalent to about 113 per million of population. Our total membership, on the other hand, is only equivalent to 88 per million of our white population, or say 22 per million of the whole, so as our chemical output per head progresses towards the British total, evidently a considerable increase in the numbre of our chemists may be anticipated.

* *Proceedings of the South African Chemical Institute, Special General Meeting, 25th March, 1922.*

That expansion is possible and also probable has been the theme of others of our presidents, but I make no excuse for returning to it to-night in view of the admitted and urgent necessity for industrial development. I shall, however, attempt to give concrete expression to the possibilities by quoting actual figures involved, and I trust that you will not only not find them "dry," but as interesting, and often surprising, as I have myself. But it is owviously impossible to go very far into details of indvidual industries within the limits of an address, little more can be done than to indicate points of attack.

It is difficult to assign even an approximate date to the beginning of chemical industry in this country, and if smelting of metals and brewing of beer be accounted chemical operations, it had its dawn, as elsewhere, in the mists of antiquity. But after the advent of Europeans the manufacture of wine, brandy, vinegar, leather and lime-burning appear to have been the earliest with which chemistry is concerned, though probably the originators were not aware of it.

Wine manufacture was established by the Huguenots in 1688, but did not attain any importance till about 1813, and some other dates of interest are the following:—

Petersen's established in 1842.
Mossop's tannery in 1846.
Sugar produced in Natal in 1850.
Copper in Namaqualand in 1852.
J. J. Hill, confectionery, 1868.
Ohlsson's Cape Brewery, 1889.
Cyanide Process introduced, 1890.
Cape Explosives Works made collodion cotton in 1903.
Carbon dioxide manufactured from magnesite, 1906.

As the needs of the population grew, chemical requirements were, of course, imported, and apart from those already mentioned, the establishment of industries definitely chemical in character, and needing the services of chemists, was comparatively recent.

To-day, fertilisers, soap, candles, cement, explosives, sugar, and alcohol are produced in considerable quantities, and as indicating how one great industry benefits others, I may quote the values of some of these products used as stores by the mining industry in 1920, that industry, I may remar,k being itself absolutely dependent on a chemical process—cyaniding.

Candles	£420,000
Cement	£93,000
Explosives	£2,065,000
Lime	£150,000
Soap	£20,000

In addition the wine, brewing, and dairy industries are all responsible for respectable outputs.

Unfortunately, only a few of these industries utilises entirely South African raw materials, but at least they all employ local labour, fuel and power, and in the result keep in the country to assist in further development capital which would otherwise go oversea.

I do not want to drag you along the thorny pathway of fiscal controversy, but I would like to urge that it would be in the best interests of the country to manufacture here the maximum possible amounts of our requirements of essentials, *i.e.*, food, housing, and clothing, for which we are at present much too dependent on oversea sources. We should take in return for our exports of gold, diamonds, coal and agricultural products, raw materials and machinery for our own industries, as well as other highly specialised products of oversea countries, motor cars, typewriters, pianos and articles of luxury which a population, as a result of this policy considerably increased in numbers and with improved standard of living, might reasonably be expected to demand. To conduce thereto, local industries should be encouraged by any and every legitimate means, and in their growth chemists will, of course, play their part.

The results of the industrial census show that the manufacturing industries now established in the country are, in the aggregate, of quite unexpected magnitude, and in a very considerable number of them we, as chemists, are or should be more or less closely concerned.

For statistical purposes they are grouped into a number of classes, those in which we are interested being:—

(I.) Raw materials; this includes tallow production, but is so miscellaneous in character that figures in connection with it are for our purposes useless.

(II.) Stone, clay, etc., in this is included cement, lime, salt pans and salt works, glass, brick and tile, etc.

(V.) Foods, etc., which includes sugar, brewing, etc.

(XI.)Chemicals, including explosives, fertilisers, oils, paints, soap and candles, etc.

From these I have extracted the following figures, which enable the importance of these industries to be gauged.

1919-20.

	No. of Factories.	Value of Land and Buildings.	Value of Machinery and Plant.	No. of Employees.
Class II.	354	£737,476	£1,113,010	13,463
Class V.	1819	£4,459,324	£4,610,879	32,958
Class XI. ...	108	£1,643,445	£2,176,080	9,160

	Value of Materials used.	Value of S.A. Material.	Value of Production.
Class II.	£635,982	£318,023	£2,407,077
Class V.	£25,046,356	£21,480,976	£35,137,533
Class XI. ...	£4,862,459	£1,518,132	£7,345,765

In addition, the value of the outputs of some specified industries is as follows:—

Grain Mills	£12,631,000.	
Jam factories, sweets, etc.	£2,132,000.	(sweets £1,150,682).
Breweries	£1,895,000.	
Butter and Cheese	£1,498,000.	
Brick, tile, earthenware and pottery	£742,000.	
Lime Works	£247,000.	
Tanneries	£1,394,000.	
Soap and Candle Factories	£3,010,000.	(including certain chemicals).
Soap	£1,616,000.	(Raw material, mostly imported, £2,312,003).
Candles	£1,030,963.	
Salt	£197,068.	(nearly 90,000 tons).
Sulphate of Ammonia	£63,088	(nearly £103,000 in 1919).
Tar	£3,382.	
Arsenic	£655.	(£1,759 in 1918).
Antimony	Nil.	(£15,292 in 1916).
Copper	£418,000.	(£1,126,040 in 1917).
Gypsum	probably £5,000 to £10,000.	
Iron Pyrites	£5,014.	
Lead	£5,270.	
Magnesite	£3,780.	
Soda	Nil.	(£29,377 in 1917).
Mineral Paints	£1,049.	

(It will be noticed that several items show decreases recently.) In Class II. a considerable variety of products is made in addition to those already mentioned, *e.g.*, acids, ammonia, arsenate of lead, barium nitrate, calcium carbide, caustic soda, charcoal, coke, copper sulphate, cattle and sheep dips, disinfectants, epsom and glauber salts, ether, ferric and ferrous sulphate, glycerine, matches, nitrate of lead, oils, greases, wax and tallow, paints, varnishes and distempers, perfumes, photographic papers, rubber goods, soda (washing, bicarbonate, arsenite, bisulphite and sulphide), tar and pitch, wattle bark extract.

Doubtless a few large concerns are responsible for the bulk of the output of each product, but with respect to the numbers of producers I find the following:—

20 manufacturing chemists (probably chiefly pharmaceutical).
13 chemical manufacturers.
4 or 5 acid works.
2 industrial alcohol producers.
14 breweries.
5 candle factories.
61 cattle feed makers.
3 cement works.
8 coke producers.
13 disinfectant manufacturers.

22 distillers.
3 explosives factories.
37 fertiliser works.
31 lime works.
14 oil and grease works, 3 edible oil producers, 4 tallow refiners.
18 paint, varnish and distemper producers.
5 rubber goods manufacturers.
50 salt works.
17 soap works.
10 soda compound makers.
30 sugar mills and refineries.
34 tanneries.
3 tanning extract makers, 26 wattle bark grinding and compressing.
12 tar and pitch.
20 wine, brandy and spirits.

Now as regards the chemist, undoubtedly a large proportion of the output of some of these industries is produced under skilled chemical control, but that is the result of the operations of a few large firms previously referred to. A large number of concerns employ no chemists at all, nor do they sufficiently avail themselves of the services of chemical consultants or analysts in private practice. But this is by no means characteristic of South Arica alone, and we can only hope that the benefits to be deirved from a closer association between industry and science will become more fully understood and seen to be mutual.

Probably between 100 and 150 chemists are employed in industries or as consultants, and the amount paid for chemical assistance is probably much less than one-half per cent. of the value of the output. Just compare that with the size of the advertising bill!

I feel that I have said enough with regard to the present position.

If the progress which has been made is not quite what has been hoped, at least chemical industry has attained considerable importance and may reasonably be expected, in spite of such drawbacks as heavy railway charges and the sparse settlement of the country, to go on making steady prorgess as the country develops and the needs of its population increase.

Future possibilities may be considered rom two aspects:—

(1) Meeting the needs of the South African population, *i.e.*, the local market.

(2) Working up South African raw materials for export.

Under (1) what chemical products doe the Union need? Which are made here an which imported? And what possibility expansion is thus indicated? A considera tion of figures affords much information.

The list of producers previously give shows how diverse our requirements are and we may perhaps turn again to th mining industry for some indication of th importance of the various items.

It may be urged that the gold mining in dustry in the Union has passed its zenith and this is possibly true, but for a lon while to come the stores it needs are nc likely to appreciably diminish, and it i more than probable that any diminution i the largest item, explosives, will be coun teracted by the more extensive use of dyna mite in coal mining and agriculture. Mean while, its other requirements, at presen largely imported, afford an indication o the direction in which expansion of th chemical industry can occur. Referring again to the figures of consumption in 1920 we find the following in addition to those previously quoted:—

Carbide	£135,000
Cyanide	£376,000
Disinfectants	£25,000
Lubricants	£375,000
Paints, etc.	£39,000
Iron	£150,000
Steel	£664,000
Antifriction metal	£32,000

The figures or imports into the Union are still more impressive, and open up the prospect of a chemical industry of considerable magnitude.

IMPORTS, 1920.

	£
Metals and Minerals ..... nearly	4,000,000
Oilman's Stores	4,384,000
Manures and Fertilisers	240,000
Sheep Dip	161,000
Dairy Products (including cond. milk, £600,000)	953,008
Pickles, sauces, etc	222,000
Wines and Spirits	891,000
Raw Materials—	
Iron and Steel	3,256,850
Nitrates	202,000
Sulphur	62,000
Tar, Bitumen and asphalte	121,000
Tin	17,000
Zinc	108,000
Glycerine	538,000
Wax, paraffin and stearine	813,000

Manufactured Articles—

Antifriction grease	112,000
Fencing Material	1,153,917
Oils	3,041,950
Paints and painters' goods	617,000
Soap	135,000
Cement	134,000
Drugs, chemicals and medicines	1,545,000
Earthenware and chinaware ...	528,000
Indiarubber goods (including tyres)	1,403,719
Perfumery	308,000

It is a coincidence that the alphabetical juxtaposition of the first two items in the mining requirements is scarcely closer than their chemical association. Cyanide, as you are aware, can be produced by fusion together of salt and cyanamide, itself produced from carbide, and the process is in commercial use in the United States.

Investigations were carried out here in the early days of the war, when the position as regards cyanide supplies gave cause for anxiety, and it was found to be quite a feasible method of production. However, supplies of cyanide became assured, and no further steps were taken to establish local manufacture.

At that time, too all the carbide used was imported, and under war conditions became sufficiently expensive to render its local manufacture an attractive proposition. To-day two carbide furnaces are successfully at work ou the Rand. Indeed, I ought perhaps to have mentioned this commodity as among those manufactures aleradv established. There is, in addition, a plant being installed in Natal to make carbide and ammonium sulphate.

But the local manufacture of cyanide has yet to be initiated, and in view of the value quoted appears to be well worthy of consideration, more especially as the mining industry will not be the only consumer.

Its use for fumigating habitations is perhaps unimportant, but agriculturally it is being increasingly used by orchardists, and no doubt will in time be required in quantity.

As compared with that produced by oversea waterpowers, electricity is still expensive here, but for interior markets this is neutralised more or less by the cost of transport from oversea, which also has to be regarded as an offset to any increased production costs incurred by the probable relatively small scale of operations.

For cyanamide itself there is bound to be an increasing consumption, whether cyanide is made from it or not, in agriculture.

In Europe in 1913, 260,000 tons of cyanamide was produced, and as this country goes in more and more for intensive farming, consumption of fertilisers must increaes, and hence also the demand for cyananide.

In due course ammonia and nitric acid will also be made from cyanamide, and, it may be, enable our explosives industry to free itself from any suggestion of being a "bastard" industry, because it operates on *imported raw material.*

*In the direction of disinfectants, medi*cines, etc., the mines obviously only consume a small portion of the present imports, and the total value is considerably greater. However, there is at present a considerable production of medicines in the Union, and the field for expansion is not large. The case for disinfectants is rather different, in which connection imports appear to bulk more largely, and which offer more prospect of increased South African production.

Lubricants constitute another very important group of materials, practically the whole of which (or raw material therefor) is imported, and I presume in the main consists of mineral hydrocarbons, with which, so far as is now known, we appear to be naturally poorly supplied. Certain vegetable and animal oils, however, are also valuable as lubricants, and though in general too high priced elsewhere, they may possibly in future be cheaper here.

There is, of course, every probability that our considerable deposits of oil shales will be turned to account and a further source of oil will lie in the development of coal carbonisation processes, in which a start has already been made, besides town gas works, by the erection at Witbank of retorts, and of a battery of Coppeé ovens at Dundee in Natal. These ovens are expected to produce benzol also, which is possibly the best motor fuel, and which, in admixture with alcohol, may render South Africa independent of imported petrol, as it is now independent of imported coke.

The need for tar, creosote, etc., increases the already bright prospects of the coal byproducts industry.

Iron and steel I have dealt with elsewhere, and it will suffice to say here that all the raw materials exist on the spot, and have been proved by the experimental

smelting of about 2,000 tons of pig iron, and that probably 175,000 tons annual production could be absorbed by the local market.

There has been deplorable delay in establishing this key industry, and as you have seen, the Government has recently announced a definite policy of encouragement, and besides contracting for half the railway requirements, has offered a bonus. So many other industries are subsidiary to this that we devoutly hope the Government efforts will be successful at no distant date. An importation valued at practically 4½ million sterling, which could largely be made here surely offers sufficient scope.

The iron industry will also assist in the direction of phosphatic fertilisers, in which the Union is naturally deficient. Nitrogen has already been mentioned, but the potash position is still indefinite. It is known, however, that we have large deposits of felspar rich in K_2O, and this can be extracted, at a cost which it may be worth paying, even if rather higher than that of importation.

It would take too long to deal with all the other items, I am afraid, but the rubber industry, with which a commencement has been made in Natal, is worthy of at least a passing mention. In the Howick factory a raw material from tropical Africa—rubber—is already being manufactured into goods, including motor tyres, and here obviously there is also room for expansion on a considerable scale.

Lastly, I would refer to the sulphuric acid industry, the key to so many other chemical industries, and in which it is a matter for concern that the country has not so far been able to meet its needs of the chief raw material, sulphur. Much less than half is, in fact, furnished by South African sulphur bearing material—pyritic concentrate, but I think there is hope for the future in the development, with improved transport, of several pyritic orebodies now difficult of access, particularly of those which are also nickel or copper-bearing.

I have already kept you too long, but export possibilities may next receive some attention.

There is in this connection a factor which has not so far received sufficient consideration, but which will, I am sure, become of the utmost importance in the future, and that is the rapid development of the, as yet, undeveloped portions of Africa. Important mineral discoveries, the usual forerunners of European activity, have already been made, advances in medical science and improvement in transport facilities are rendering accessible vast areas which may be regarded as our natural markets, to which we shall supply manufactured articles, and from which we shall draw raw material.

The figures hereunder, of exports during 1920, show that, in addition to exporting raw material, some at least of which could receive further treatment before export, a beginning has already been made in the exportation of manufactured goods.

Exports, 1920.	£
Aloes	15,000
Argol	8,000
Wattle Bark	986,000
Buchu leaves	67,000
Maize	344,000
Raw Cotton increasing very rapidly	70,000
Hides and Skins	4,218,755
Wool	16,000,000
Sugar	456,000
Molasses and Treacle	82,000
Ale and Beer	36,000
Salt ... tons	1,375
Blasting Compounds	243,000
Candles	15,000
Confectionery aud jams	150,000
Drugs	13,000
Manures	74,000
Soap	42,000

This I find especially encouraging.

We have all no doubt had the experience of hearing how impossible it would be to *make* such and such a product in the country, let alone export. In my own experience I need only mention the smelting of tin and local manufacture of cast steel shoes and dies, now accomplished facts. To go further back, I once came across a carefully reasoned statement, which proved beyond doubt that a railway between London and Birmingham was chimerical, and in any case could never pay.

Personally, I prefer to consider all things as possible, and in view of the rapid advances in all directions which have taken place even within our own recollection it is indeed a bold man who would in almost any connection predict impossibility wherever probability is shown. Improbability is quite another matter.

To resume, there are in my opinion a few outstanding possibilities in connection with exportation of the products of "chemical" industries, though it must be borne in mind that many countries, while admitting raw material free, impose protective duties on products manufactured therefrom. (In view of this position already existing whence comes the danger of inviting retaliation if we do likewise? Rather would we provide ourselves a counter to bargain with.)

It will be observed that both hides and wattle bark to tan them with are exported in large quantities. On the other hand, South African sole leather at least is of proved excellence—the inference is surely obvious!

Maize again is largely used overseas as a raw material for manufactured products—among which I have heard whisky mentioned—and our small beginnings in that direction should lead to big things. We should export and not import starch and glucose.

Cotton is an item which grows rapidly in importance year by year, and has every prospect of a brilliant future. Cotton seed oil and cake are elsewhere very important by-products, and must inevitably increase in quantity here. Wool to-day is largely exported "in the grease." It is true wool washing is already a South African industry, but it appears to be capable of considerable growth and extension in scope, so as to produce lanolin, potash, etc. The sugar industry will probably increase its export of wax and alcohol, and the other manufactured products imported are all likely to increase in amount as the interior of the continent is opened up; in addition, there are great possibilities in connection with vegetable oils and their products, including edible ones.

Among food products a more scientific conduct of the wine and spirit industry—unless prohibited—will increase oversea demand with improved quality, and the growth of apple orcharding may well result in production and export of cider; other orchards will furnish raw materials for fruit essences, citric and tartaric acids, and essential oils will be prepared also—*vide* eucalyptus, peppermint, lavender, to mention only a few sources which flourish somewhere or other in our variety of climates.

The development of the meat industry will lead to canning factories, and the production as side lines of glue, gelatine, tallow and fertilisers; dairying similarly to casein and milk sugar, though it is doubtless a far cry at present.

In concluding, I will deal briefly with the mineral and metallurgical side. I think the chief chances of establishing an export trade in metallurgical products is in connection with ferro-alloys—the products of electric furnace smelting in which high cost of power is largely balanced by saving in freight. Ferro-chrome could certainly be made here from our chromite; in view of the probable costs and oversea selling price, it is probable that it could be profitably exported.

Ferro-vanadium is another probability. It has been found that our immense deposits of titaniferous iron ore carry appreciable amounts of vanadium, and its commercial extraction is, I feel certain, only a matter of time.

Ferro-tungsten is more doubtful, but promising occurrences of scheelite are known, and as this mineral is one likely to escape the notice of the average prospector, systematic search may reveal much larger supplies.

Molybdenum also has been reported in several places, and from information I have will probably be found in time to justify exploitation.

I think I have said enough to show that, although its growth may not be spectacular, the hopes entertained regarding the future of chemical (and metallurgical) industry in South Africa, to which I have endeavoured to give quantitative expression, have not been lacking in foundation; and that it has every probability of being prosperous. May we all share in the rewards, as we assuredly will in the toils, of the advance.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Section I.—Physiology.

THE EFFICIENCY OF MAN AND THE FACTORS WHICH INFLUENCE IT.

Address by Prof. E. P. Cathcart, M.D., D.Sc., F.R.S., President of the Section.

(*Continued from Page* 318.)

It can be shown that if a certain distance has to be covered in a definite time there is an optimum rate of forward progression. Cathcart, Lothian, and Greenwood found, for example, that when the cost per mile alone was considered, the minimum value was reached at a rate of about three miles

per hour, but when the question of time as well as distance arose, *i.e.*, if a distance of, let us say, one mile was to be covered and sixty minutes were available to do it in, *would it be more economical to march the* mile rapidly or slowly and have a longer or shorter period of rest? Our experiments showed that the lowest hourly value was obtained at a rate of a mile in about 23 minutes, *i.e.*, marching for 23 minutes in the hour and resting for 37 minutes. To spend 32 minutes on the march cost about 5 per cent. more, and to reduce the marching time to 16 minutes increased the cost by about 15 per cent.

So much, then, for the ordinary effector factors. There are many other factors *directly concerned with the efficient action* of the organism, some directly influencing the internal economy of the body, others acting more indirectly on the organism from the enviornment.

One of these factors is the state of the nutrition. It may be definitely stated that an insufficient intake of food or the consumption of poor or inadequate food is one of the chief sources of general inefficiency. Our resistance to the effects of hard and continual work, just as to the effects of an infection, is largely controlled by our reserves. The capacity of the body to store reserve food material which will meet the daily demands for energy and leave a surplus is another of the vital factors of safety. The body is undoubtedly capable of withstanding complete deprivation of food for comparatively long periods, but with a corresponding depression in its capacity to perform external work. Complete starvation is a state which is rare, and does not affect the question at issue. The much more important problem is unfortunately only too common, the influence of chronic undernutrition, a condition which lowers efficiency, not merely in the actual performance of muscular work, but by inducing an increased susceptibility to disease. This is a question which has never received the attention which its importance demands, largely on account of the immense difficulties of carrying out the investigation in a practical manner. As the direct result of the war we have the records of at least two sets of observers. Benedict and his co-workers investigated the problem, using a *group of twelve men, comparing them with* a similar group drawn from the same class. In the experimental group the food intake was reduced, so that there was a loss of 12 per cent. of the body weight. Although the experiment was carried on for over four months, and the basal metabolism was reduced by 18 per cent., the diminution in muscle power, so far as laboratory tests were concerned, was not great. The subjective impression, however, of the subjects was that they felt weaker and less capable.

The other recorded experiment is that of the condition in Germany during the war years. A general statement of the effects of the blockade is contained in a long document prepared by the German Government (dated December, 1918). Admittedly the document was prepared for a specific purpose; but, after making all allowances, the *record of the far-reaching effects of chronic* underfeeding is valuable. It may be remarked that many of the statements receive corroboration in the report drawn up by Professor Starling on the food conditions in Germany. Apart from the increased death rate, the increased liability to disease, and the slow recovery from the attacks of disease, the document definitely states that the working capacity of the people was reduced by at least one-third. The following sentence gives probably an accurate picture of acute undernutrition, associated, it is true, with much emotional strain: "Everywhere in Germany it may now be observed how, in the four years' struggle for daily bread, the people have lost all their vigour and capacity for work; how all spirit of enterprise is gone."

Here, then, we have the actual record of an experiment on a gigantic scale. Personally I believe that these results are much more likely to be the ordinary sequence of underfeeding than the laboratory results of Benedict. I do not doubt for a moment his records, they are beyond reproach; but I feel that many of the excellent results which were obtained when the test subjects competed with subjects on ordinary food were in part due to the quite natural desire of the men to demonstrate to their friends and the onlookers that they were fit. In other words, there was a strong psychic element which vitiated the test as a real test for efficiency.

Evidence, much debated it is true, would indicate that it is not only the quantity but the quality of the food consumed which *plays a part in the fitness of the individual* to perform hard muscular work. All modern work would seem to point to the conclusion that if the caloric value of the food sup-

plied is adequate the actual demand for protein is very small. It is very difficult, however, to believe that the far-reaching common belief in the efficacy of a high meat intake, despite the scientific evidence to the contrary, is without some foundation. It is possible that the value of meat (flesh) depends not merely on the high biological value of its protein, but also on the fact that it can act as a stimulant of cellular activity; that, in other words, it is desired for its stimulating effect, for giving, in that expressive transatlantic word, "pep."

Another factor which plays an enormous rôle in the general efficiency is the response of the organism to the multiple psychic imponderabilia which compose such a large part of the average environment. Although for general purposes, such as the calculation of mean or average demands, it may be both convenient and useful to assess the data on an average man basis, yet it is the individual variation which controls the actual operating conditions. When we are dealing with the efficiency of the human organism, male and female, we are dealing with individuals whose performance is neither uniform throughout the year nor from week to week, nor even from hour to hour. We have to deal with an organism, as I have already mentioned, which is not only under physical control, but is very responsive to physic influences—an organism which not only becomes in the course of the day physically "tired," but which unconsciously is influenced to an enormous extent by its environment, by its "atmosphere." Man is, in the main, a psychic chameleon.

In this connection monotony of work must be considered. The Health of Munition Workers' Committee stated that monotony is "analogous to, if it does not represent, a fatigue process in unrecognised nerve centres." It is true that monotonous work, be it light or heavy, may be, as Goldmark maintains, "more damaging to the organism than heavier work which gives some chance of variety, some outlet for our innate revolt against unrelieved repetitions." Still, although there may be a close relationship between monotony and fatigue, as generally recognised, they are not identical. The temperament of the operative plays an enormous part in the determining whether or no any particular operation is a monotonous one. Thus a skilled engineer put on to attend an automatic machine which requires the minimum of skilled attention would soon be disgusted with the monotony of the operation even if the pay were good, whereas an unskilled worker, especially if of a lower degree of intelligence, could attend to such a machine without strain. Munsterberg has recorded a number of most interesting examples of this seeming imperviousness to monotony even on the part of apparently intelligent individuals. Probably, indeed, if the operation is a slow one, or, if quick, one in which the movements are relatively simple, the dull individual—the organism with few trained receptors—and the worker with intelligence above the average, who readily masters the performance and can then let his mind free to speculate on his own private interests, will stand the strain better than the worker of average intelligence. As Munsterberg has shown, it is extremely difficult, if not impossible, for an outsider to determine what a monotonous operation is. It is obvious that if A is interested, let us say in epigraphy, he will judge that B, engaged in some simple routine stamping or packing job, is employed on a monotonous operation, whereas it would be equally likely that if B were asked his opinion he would candidly state that he would not exchange his interesting work for the dull and monotonous pursuit of A.

There are many other factors which play a definite and important rôle in the maintenance of efficiency, such as lighting, heating, ventilation, the mode of life led by the worker outside his definite hours of labour, his housing, &c. Many of these factors have been partially examined. Thus Leonard Hill has carried out a great deal of valuable work on the influence of the cooling power of the air. Vernon has collected much interesting evidence which shows that there is a very definite relation between the efficiency, as measured by output, and the temperature of the working place. The output in the hottest weather was about 30 per cent. below that when the weather was coldest. He also observed an apparent connection between the relative humidity of the air and the efficiency of the worker. The efficiency, as might have been expected, was apparently greatest when the relative humidity was low. Elton has reported on the influence of lighting in silk weaving. He found that the output was lowest when artificial light was used. He stated that even when electric light of sufficient intensity was used, the output was

about 10 per cent. below the daylight value. The actual equipment of the factories, the provision of seats of suitable size, height, &c., the design of the machines, and so on, all play their part, as is shown by the many records, particularly from the United States.

In other words, the real overall industrial efficiency of the worker cannot be casually related to any single factor. It is not the mere capacity of the individual to perform so many kilogrammètres of work in a given time with the smallest expenditure of energy. The quest of efficiency is one of the most intricate problems in its infinite ramifications throughout the physiological and sociological structure which has ever called for solution, and it involves the whole welfare of our race and nation. It calls for the closest and most intimate co-operation between the scientific investigator, the employer and the employee, and is no more capable of being settled on a communistic than on a capitalistic basis. It can only be satisfactorily attacked when mutual distrust of motives, capacities, and methods is stilled.

INTERMETALLIC ACTIONS.

THE SYSTEM ALUMINIUM-ARSENIC.

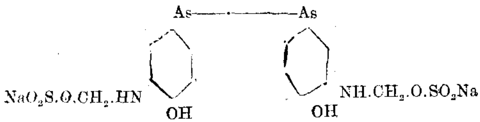
By Q. A. Mansuri.

Although it has been stated that As combines with Al at high temperatures, little is known regarding the reaction. The present author finds that by heating a mixture of Al and As in a sealed tube at 800° and at low pressure, yellow arsenic is formed which reacts with the Aluminium give a brown compound of the formula Al_3As_2. This is stable at high temperatures, but is not so at low temperatures. Attempts to prepare another compound of a higher arsenic content were not successful. Al_3As_2 gives arsenic trihydride when exposed to moisture, and when heated in air is oxidised to Al_2O_3 and As_2O_3. The formula established for this compound is of the type usually given to other metallic-arsenic compounds, viz., M_3As_2.—(*J.C.S. Trans.*, p. 2277, 1922.)

SULPHARSPHENAMINE.

By C. Voegtlin and J. M. Johnson.

This is the name given by the authors to the compound prepared from the hydrochloride of 3, 3′-diamino-4, 4′ dihydroxy arsenobenzene, otherwise known as arsphenamine, formaldehyde and sodium bisulphite. It resembles neoarsphenamine in many respects. For its satisfactory preparation, arsphenamine is completely dissolved in a mixture of alcohol and water, and formaldehyde added, vigorously stirring during this addition. This gives a condensation product with the HCHO attached to both amino groups. Shortly after this addition, the formaldehyde-imide compound is treated with sodium bisulphite, giving rise to a sulphurous acid ester salt. The orange red solution is now poured in a thin stream into a large volume of alcohol, and the precipitated compound filtered off, washed with alcohol and dried. For successful work, care has to be taken as regards the time allowed for each stage of the reaction, and the rate at which the reacting substances are added. It is considered that this drug consists of an arseno-benzene derivative of the constitution:—



Experimental work has shown that the compound is suitable for subcutaneous injection in the case of protozoal diseases.—(*Journal American Chemical Society.*)

ESTIMATION OF STARCH IN BARLEY AND WHEAT.

This problem has recently been the subject of investigation at the British School of Malting and Brewing of the University of Birmingham, by Professor Arthur R. Ling, the work described being carried out under the Institute of Brewing Research

Scheme with the aid of a grant from the Institute's Committee. Professor Ling read a paper on the subject at a joint meeting of the Birmingham and Midland Section of the Society of Chemical Industry and the Midland Counties' Section of the Institute of Brewing, at the Birmingham University, on Thursday, November 23. Dr. Edward B. Maxted, of the former Society, presided over a very large attendance.

Starch, said the author, was the most widely disseminated reserve carbohydrate in the vegetable kingdom, and it had an economic importance possessed by few other vegetable products. In some form or other it entered into the dietary of man and animals to an extent exceeded perhaps by no other substance, whilst its many uses in the arts gave it a prominent position in several branches of chemical industry. It was remarkable, therefore—Professor H. E. Armstrong had said that it was little short of a disgrace—that up to the present, despite numerous attempts, no really satisfactory method of estimating starch had been devised. To the agriculturist, to the maltster, and to the brewer an accurate method of estimating starch was of the utmost importance, seeing that starch was the main constituent of all cereals. Professor Ling, after a review of the methods which had been proposed for estimating starch from the earliest times, concluded that C. O'Sullivan, in 1884, had approached the problem on sounder lines than any previous or subsequent investigator. Dr. Horace T. Brown and his co-workers in the celebrated Guinness researches, had found O'Sullivan's method to be on the score of accuracy the best which had been proposed. The length of time required for carrying out the method ruled out its application, however, for practical purposes. The Guinness workers had devised a rapid method of estimating starch, depending on the fact that when malt diastase acts on starch at 55-60 C., there is an apparent resting stage in the reaction. According to this, the percentage of maltose produced at the end of a given time (say 1 hour) bears a constant relation to the starch originally present. The actual percentage of maltose found in this way does vary, however, according to the diastatic power of the malt employed, and Professor Ling has now determined the relation of the maltose produced to the diastatic power of the malt employed. Barley and wheat starches were found to give identical results. Ground barley or wheat is extracted for three hours with alcohol of specific gravity 0.920, which removes some of the proteins. It is then converted into a paste with hot water and treated with the extract of a malt of known diastatic power for an hour. The maltose is then estimated and the starch calculated by the formula: $S = 94.73 M'/M$, in which S is the percentage of starch in the sample, M is the percentage of apparent maltose produced from dry barley or wheat starch by the action of malt extract from malt of a definite diastatic power, and M' is the percentage of apparent maltose produced from the sample and with malt of the same diastatic power. Tht values 63.9 and 64.0 were obtained as the percentage of starch in the dry wheat. Some of the same wheat was then mixed with pure wheat starch of known moisture content and the mixture analysed, employnig a malt of diastatic power 67° (Lintner). The agreement was satisfactory, and Professor Ling takes the view that he and his collaborators are justified in the conclusion that the method gives satisfactory results. It was applied to cereals grown on the famous *Broadbalk field* at Rothamsted Agricultural Research Station, Offichurch. The method is to be adopted as a standard method. Professor Ling intends to extend his work to other starch-containing substances.

POTASSIUM AZIDO-DITHIO-CARBONATE.[1]

By A. W. Browne and A. B. Hoel.
(*With Notes on Crystallography by A. C. Gill.*)

[Contribution from the Department of Chemistry of Cornell University.]

In connection with an investigation of the imide character of hydronitric acid, F. Sommer[2] succeeded in preparing and ana-

[1] *The investigation upon which this article is based was supported by a grant from the Heckscher Foundation for the Advancement of Research, established by August Heckscher at Cornell University. The present paper is Article No.* 3 *under Heckscher Grant No.* 4. *For Articles* 1 *and* 2 *see Jour. Amer. Chem. Soc.*, 1922, XLIV., 2106 *and* 2116.

[2] *Sommer, Ber.*, 1915, XLVIII., 1933-41.

lyzing the hydrated sodium and barium salts of a new acid, which he named azido-dithiocarbonic acid. These compounds were shown to have the formulæ $NaSCSN_3.4H_2O$ and $Ba(SCSN_3)_2.5H_2O$. When the attempt was made by Sommer to prepare the corresponding potassium salt by a similar method, the crystalline product that he obtained exploded with violence as he spread it carefully, with the aid of a porcelain spatula, upon a porous plate, thus deterring him from further work upon this compound.

The formation of potassium azido-dithiocarbonate has been shown by the authors of the present paper[3] to take place slowly, even at ordinary temperatures, when carbon disulphide is brought into contact with aqueous solutions of potassium trinitride. It has, moreover, been demonstrated that an important catalytic effect is exerted by this azido-salt in the reaction between aqueous solutions of potassium trinitride and iodine in presence of carbon disulphide. In this connection it has been found necessary to prepare and analyze the azido salt, and to study certain of its properties and reactions.

Method of Preparation.—A sample of pure potassium trinitride weighing 6 g. was dissolved in 25 cc. of distilled water, and the resulting solution, in a 100 cc. glass bottle, was treated with about 6 g. of pure, redistilled carbon disulphide, an amount lsightly in excess of that required for the ratio $KN_3:CS_2$. The tightly corked bottle containing the reacting mixture was held at a temperature of about 40° in a water-bath, with occasional shaking, until the carbon disulphide had entirely disappeared.

A convenient test indicating the completion of this reaction consists in adding a few drops of iodine solution to a small sample of the reacting mixture. Immediate discharge of the iodine colour, unaccompanied by perceptible evolution of nitrogen, conclusively proves absence of unchanged potassium trinitride, as this substance would be quickly decomposed by the iodine, in presence of the azido salt, with quantitative liberation of nitrogen.

The solution of potassium azido-dithiocarbonate obtained by this method was concentrated over phosphorus pentoxide in a vacuum desiccator, almost to the point of saturation, and was then filtered carefully to remove free sulphur. The clear filtrate was slowly cooled over ice until the formation of crystals took place. The crystals were cautiously removed, and were dried, first between filter paper, later on a porous plate, with the aid of a bone spatula, and finally in a vacuum over phosphorus pentsetoxide. Failure of the crystals, after thorough drying between filter paper, to lose appreciable weight when stored in a vacuum over phosphorus pentoxide for 60 hours, corroborated at the outset the opinion of Sommer that the potassium salt, unlike the salts of sodium and barium, ordinarily crystallises from aqueous solution in the anhydrous condition, a fact that has been verified repeatedly in subsequent work.

Analysis.—Carefully dried samples of potassium azido-dithiocarbonate prepared by the foregoing method were analysed as follows. The potassium was determined by heating weighed samples of the compound with sulphuric acid, and weighing the potassium sulphate formed.

Subs., 0.1677, 0.3381; K_2SO_4, 0.0932, 0.1889. Calc. for $KSCSN_3$: K, 24.86. Found: 24.94, 25.07.

The sulphur was determined by oxidizing weighed samples of the salt with conc. nitric acid and bromine, and weighing the sulphur in the form of barium sulphate.

Subs., 0.4502, 0.4669: $BaSO_4$, 1.3550, 1.3942. Calc. for $KSCSN_3$: S, 40.78. Found: 41.34, 41.01.

The nitrogen was determined by combustion of the azido salt with copper oxide in a current of pure carbon dioxide. The explosive character of the salt necessitated admixture with precipitated silica and with copper oxide in finely divided form. The mixture was distributed through the combustion tube over a length of about 25 cm.

Subs., 0.1343, 0.1629; N_2, 28.53 cc. (0.03568 g.), 34.75 cc. (0.04346 g.). Calc. for $KSCSN_3$: N, 26.73. Found: 26.57, 26.68.

Crystallographic Data.—Samples of the white crystals were submitted to Professor A. C. Gill, of the Department of Geology of Cornell University, who makes the following statement concerning their properties:

"The crystals examined presented quite variable habitus, though tabular development with 4-sided or 6-sided outlines was most common. The 6-sided crystals usually showed elongation parallel to the direction which may be designated in this description

[3] *Browne and Hoel, Jour. Amer. Chem. Soc.*, XLIV., 2109 (1922).

as the macro-axis, though accurate determniation of the crystallographic constant was rendered impossible, with the apparatus at hand, by the rather rapid deliquescence which the substance undergoes. The 4-sided crystals gave angles of very nearly 87° and 93° on the stage of a petrographic microscope. This would indicate an axial ratio of a:b = 0.95:1. Not even approximate measurements of the length of "c" axis were obtained. Reticulated masses very like the well-known occurrence of lead carbonate in nature were frequently observed under the microscope on evaporating the liquid in which the azido-salt had been formed on a warm glass slide. Five-sided crystals, bounded by the prism and one face of the macro-pinacoid, were rather frequently observed, but, on the whole, this was not thought to indicate a hemimorphic symmetry, as the parallel face was usually observable unless the development of the one face was rather small. The optical behaviour of the tabular crystals is the best argument for their rhombic character. They show parallel extinction in all positions, even in the reticulated masses. They are optically biaxial with a large angle, 2 *V*, greater than 75°. The axis of greatest elasticity bisects the acute angle o fthe prism, while the axis of least elasticity is normal to the tabular face (001). The optical character seems to be positive, though there is a possibility that the optical angle as seen in the ordinary position is greater than 90°, in which case the crystals are negative.

"Double refraction is rather strong, estimated at 0.050, and dispersion is very unusual. From the peculiar purple appearance of the first order red interference colour it would appear that the birefringence for red light is much stronger than for blue, so that a thickness of crystal producing 200 to 230$\mu\mu$ retardation for the blue end of the spectrum produces something like twice that amount for the red end. Careful study of the substance by monochromatic light would be necessary to confirm the accuracy of this explanation."

Solubility.—Potassium abido-dithiocarbonate is very soluble in water, and deliquesces rapidly under ordinary atmospheric conditions. No accurate determination of the solubility was made, partly because of risk attending the use of relatively large amounts of this explosive substance. As a first approximation, however, small samples of the salt were weighed on watch crystals. These were again weighed just as the last crystal was dissolving in the moisture condensed from the atmosphere. Samples weighing 0.0225 and 0.1720 g. were found to dissolve in 0.0049 and 0.0381 g. of water. One part of water will, therefore, dissolve about 4.5 parts of the azido-salt.

When brought into contact with various non-aqueous liquids, all strictly anhydrous, the azido salt was found to be fairly soluble in both methyl alcohol and acetone, very slightly soluble in ether, and practically insoluble in ethyl alcohol, benzene, carbon tetrachloride, carbon disulphide, and chloroform.

—*From the Journal of the American Chemical Society*, 1922, p. 2315-20.

(*To be Continued.*)

PROCEEDINGS OF SOCIETIES.

ROYAL SOCIETY.

Papers read December 7th, 1922:—

LORD RAYLEIGH, F.R.S.: *Spectrum of Active Nitrogen as affected by Admixture of the Inert Gases.*

G. H. HENDERSON, PH.D.: *Changes in the Charge of an α Particle passing through Matter.* Communicated by Sir Ernest Rutherford, F.R.S.

W. T. ASTBURY: *The Crystalline Structure and Properties of Tartaric Acid.* Communicated by Sir William Bragg, F.R.S.

J. N. MUKHERJEE: *Sources of Error in the Measurement of the Electrical Charge of Colloidal Particles by the Method of Moving Boundaries. An improved Method based on a direct Measurement of the Potential Gradient across the Boundary.* Communicated by Prof. F. G. Donnan, F.R.S.

J. HEYROVSKÝ: *The Significance of the Electrode Potential.* Communicated by Prof. F. G. Donnan, F.R.S.

A. M. MOSHARRAFA: *On the Quantum Theory of the simple Zeeman Effect.* Communicated by Prof. O. W. Richardson, F.R.S.

S. BRODETSKY: *Discontinuous Fluid Motion past Circular and Elliptic Cylinders.* Communicated by Prof. G. H. Bryan, F.R.S.

THE CHEMICAL SOCIETY.

ORDINARY SCIENTIFIC MEETING, THURSDAY, DECEMBER 7TH, 1922, AT 8 P.M.

The following papers were read:—

The isoelectric condition of gelatin: S. O. RAWLING and W. CLARK.

Studies on metal hydrides. The electrolytic formation of stibine in sulphuric acid and caustic soda solution: H. J. S. SAND, E. J. WEEKS, and S. W. WORRELL.

THE FARADAY SOCIETY.

At the Annual General Meeting held on November 20th, the following Officers and Council were elected to serve for the year 1922-1923:—

President, Sir Robert Robertson, K.B.E., F.R.S.

Past Presidents, Sir R. T. Glazebrook, K.C.B., F.R.S., Sir R. A. Hadfield, Bart., F.R.S., Professor A. W. Porter, F.R.S.

Vice-Presidents, Professor C. H. Desch, Professor F. G. Donnan, C.B.E., F.R.S., Dr. J. A. Harker, F.R.S., Professor T. M. Lowry, C.B.E., F.R.S., W. Murray Morrison, Professor J. R. Partington, Dr. G. Senter.

Treasurer, Robert L. Mond.

Council, W. R. Bousfield, K.C., F.R.S., Cosmo Johns, Dr. R. Lessing, Professor W. C. McC. Lewis, Professor J. W. McBain, Dr. H. Moore, C. C. Paterson, Dr. J. N. Pring, Professor A. O. Rankine, Dr. E. K. Rideal.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

At the meeting of the Society held on Wednesday, December 6th, at the Chemical Society's Rooms, Burlington House, Piccadilly, W., at 8 p.m., the following papers were read:—

A Note on the Estimation of Form- and Acet-aldehydes, by E. W. BLAIR, B.Sc., D.I.C., A.I.C., and T. SHIRLOCK WHEELER, B.Sc., A.R.C.Sc.I., A.I.C.

A Sliding Scale for the Convenient Titration of Strong Liquids by Dilution and Use with Aliquot Parts, by C. H. DOUGLAS CLARK, B.Sc., D.I.C., A.I.C.

Note on the Presence of Sulphur Dioxide in Cattle Foodstuffs after Fumigation, by H. A. PEACOCK, B.Sc.

Some Observations with regard to the Unsaponifiable Matter and Sterols of Edible Fats, by D. W. STEUART, B.Sc.

Note on the Sulphuric Acid Test or Fish Liver Oils, by NORMAN EVERS, B.Sc., F.I.C., and H. J. FOSTER.

THE INSTITUTE OF METALS.

The Institute of Metals are admitting student memberships to be transferred to full ordinary memberships at the age of 25. The entrance fee is one guinea and the annual subscription one guinea.

Student members will be elected on Dec. 14th, and will have all the privileges of ordinary members except that of voting at meetings.

THE INSTITUTION OF RUBBER INDUSTRY.

"FUEL OIL."

By A. F. Baillie.

A meeting of the Manchester Section of the Institution of Rubber Industry was held at the Midland Hotel, Manchester, on Monday, November 20th. Mr. J. H. Mandleberg presided over a very large attendance of members.

The above-titled paper was read by Mr A. F. Baillie, Chief Technical Engineer, Shell-Mex, Ltd., and dealt particularly with oil burning for raising steam in relation to the rubber industry.

Mr. Baillie said that fuel oil is used firstly at the wells for raising steam in connection with the drilling of the wells. It is also used at the refineries as a heating agent under the stills, and also as a fuel for steam-raising in various types of boilers. Fuel oil is further used in steamships for generating steam in their boilers for supplying the main engines. Again, fuel oil is used for steam-raising in numerous types of land boilers, also on locomotives and heating furnaces for metallurgical work.

In the consumption of fuel oil as a heating agent, it is first necessary to divid

finely or atomize the fluid, so that it can be mixed with the necessary quantity of air to make the resultant a combustible mixture. This process is called "atomization," and is effected by means of apparatus called "fuel-oil burners." These burners are manufactured by various engineering firms and come under three systems: (1) Air-jet System, (2) Steam-jet System, and (3) Pressure-jet System.

The first system used air under pressure as an atomizing agent. Low-pressure air is blown from a motor-driven fan, although for special classes of work, such as the manufacture of electrical bulbs and other white-glass ware, high-pressure air has in the past been used, and is supplied by blowers or compressors. For some particular classes of work it has been found to be an advantage to take all the air for atomizing and combustion through the burner, and in this case the air is intermingled with the oil in the burner, the proportion being 207 cubic feet of air per lb. of oil. Thus, due to all the air being under control, an oxidising or reducing flame can be obtained at will. For other classes of work the usual procedure is to take approximately 60 per cent. of air through the burners, and induce the necessary extra quantity of air from the atmosphere to complete combustion.

The second system, viz., the steam-jet system, uses steam under pressure as an atomizing agent. It is usual to take this steam from an auxiliary stop valve on the boiler or from a tee on the auxiliary steam line, and reduce the pressure of this steam from boiler pressure to 15 to 25 lbs. per square inch. The proportion of steam required for atomizing, say Mexican Fuel Oil, is approximately 3lbs. of steam per lb. o oil, or, on the other hand, say 1½ to 2 per cent. of the total steam evaporated. Again, with the steam-jet type of burner, the requisite amount of air to complete combustion is induced from the atmosphere.

The third system, viz., the pressure-jet system, sprays the oil under pressure by means of a steam-driven pump, and also uses steam temperature to thin or reduce the viscosity of the oil. This latter system has been developed during the last 10 years to such an extent that it is recognised as the most economical system for burning oil under land and marine boilers. In this system oil is drawn from the storage tanks by means of a steam-driven pump through suction strainers and pumped through fuel-oil heaters and discharge strainers to the fuel-oil burners. The object of the suction strainers is to collect any foreign matter in the oil so as to protect the suction and discharge valves of the pump. The object of the heaters is to raise the temperature of the oil to such a degree that the oil, when intermingled with sufficient quantities of air, is suitable for combustion. The object of the discharge strainers is that, after the oil is passed through the heaters, a certain amount of foreign matter is released and is then trapped by these strainers so as not to choke the nozzles of the burners, as these nozzles are very fine, ranging from 1 to 2.5 mm. The hot oil under pressure issues from the burner in the form of a fine whirling mist. The necessary air for combustion is introduced through special furnace fronts, which slightly pre-heat the air and impart to it a rotary motion in the opposite direction to the burner spray, in order thoroughly to intermingle and mix the oil spray and air supply, and so give complete combustion in the furnace. The quantity of air for combustion is under absolute control by means of dampers or air controls, fitted to the furnace front. These air controls can be fitted when using either natural or forced draught.

These three types of burners have their various uses, the steam-jet being used generally for small land boiler plants, the pressure-jet system for large boiler plant and marine purposes, and the air-jet system for furnace heating and metallurgical work.

For comparative purposes, and assuming each of these systems tested under a steam boiler, there would be obtained a thermal efficiency of approximately 78 per cent. for the steam-jet system, 80 per cent. for the air-jet system, and 85 per cent. for the pressure-jet system.

CORRESPONDENCE.

CARBON SUBOXIDE.

To the Editor of "The Chemical News."

Sir,—I notice, according to a paper recently published in the *Berichte*, that Messrs. Ott and Schmidt have devised a method whereby Carbon Suboxide can be prepared in a higher degree of purity and in much larger quantities than heretofore. It is to be hoped that the vexed question of the constitution of this substance will now be definitely settled. In this connection I

should like to call attention to a paper of my own, published in Vol. 120 of *The Chemical News* (pp. 209 and 210), in which I point out that the heat of combustion of this substance would provide a perfectly satisfactory criterion for deciding between the two alternative constitutional formulæ. Unfortunately, I lack the facilities for carrying out the necessary experiments and determining the heat of combustion of the substance myself, but I trust that this will now be done by some investigator more fortunately circumstanced than myself.

I am., Yours, etc.,

H. STANLEY REDGROVE.

191, Camden Road, London, N.W.1.

NOTICES OF BOOKS.

The Theories of Organic Chemistry, by DR. F. HENRICH, translated and enlarged from the fourth German edition of 1921 by TREAT B. JOHNSON and DOROTHY A. HAHN, PH.D. Pp. XVI. + 603. London: Chapman & Hall, Ltd. 1922. Price 30s.

Thanks to the laborious and praiseworthy efforts of the American translators, Prof. Henrich's volume has now become more accessible and available for English speaking chemists.

The literature of organic chemistry is so extensive and hypotheses undergo constant change and revision, or are entirely cast aside as new developments and discoveries are made, that the authors have necessarily been unable to give a complete review of the whole subject. They have, however, presented a valuable record of the progeess and the theoretical deductions therefrom in the field of organic chemistry.

In the portions on the history of Structural Chemistry, the ideas of Frankland, Kolbe, and later, those of Kekulé, Van't Hoff, von Bæyer, and Thiele are carefully developed.

Recent speculations relating to the Electronic Conception of Valency have been quoted at some length. Such subjects as the Relation between Colour and Constitution and the Theory of Indicators have naturally received attention. The concluding chapter deals with recent and important Electrochemical Theories.

It is evident that in some parts, for the sake of clearness, the matter has been rewritten rather than merely translated. Several new chapters have also been introduced, and other additions have been made to include the results of recent researches, especially those by Americans.

Prof. Henrich has written a preface to this edition, approving of these alterations and additions which the translators have made.

This work forms, therefore, a useful source of information for advanced students and those engaged in teaching Chemistry.

J.G.F.D.

New Patents.

THIS list is specially compiled for the *Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

30632—Carmichael & Co., Ltd.—Apparatus for manufacture of sulphuric acid. Nov. 9.

30593—Chemische Fabrik Greisheim-Elektron.—Production of stable compounds of calcium hypochlorite. Nov. 8.

30772—Coley, H. E.—Reduction of ores, oxides, etc. Nov. 10.

30932—Imray, O. Y.—Manufacture of azo-dyestuffs, and chromium compounds thereof. Nov. 10.

30301—Lijunden, L. L. J.—Process of obtaining metals from their chloride vapours. Nov. 6.

30300—Lijunden, L. L. J.—Chloridizing volatilization of metals. Nov. 6.

30837—Lindsay, W. B.—Elimination of sulphur from oil. Nov. 10.

Specifications Published this Week.

187636—Potter, C. K.—Manufacture of chromium compounds.

174370—Rhenania Verien Chemische Fabriken Akt-Ges.—Process for rendering soluble crude phosphate.

165752—Rheinsch-Nassauische Berwerke & Hutten Akt-Ges.—Method of producing chemically-pure hydrochloric acid.

181313—Manufacturers De Produits Chimiques Du Nord Etablissements Kuhlmann.—Mechanically-operated furnaces for roasting pyrites.

Abstract Published this Week.

Chlorinating Methane.—Patent No. 186270.—A new process for the chlorination of methane has recently been Patented in this country by Messrs. Holzverkohlung Industrie, Akt-Ges., of Konstanz, Baden, Germany.

Steam is employed as a diluent to the reacting gases to moderate the violence of the reaction, and at the same time to supply, if necessary, the heat for its initation. In general 2-5 volumes of heat for its initiation. In general 2-5 volumes of steam per unit volume of chlorine are used, and temperatures above 650° C. are avoided owing to temperature above 650° C. are avoided owing to the decomposition of steam and formation of oxides of carbon. Catalysts such as chlorides of copper, iron, and the alkaline earth metals may be employed, with or without porous carries. The relative proportions of the reacting gases are dependent on the dimensions of the reaction tubes and upon the products required. Examples are given in which the methylene dichloride chloroform, and of carbon tetrachloride is promoted.

Messrs. Rayner & Co. will obtain printed copies of the published Specifications, and forward on post free for the official price of 1s. each.

THE CHEMICAL NEWS,

VOL. CXXV., No. 3270

ORDINARY GENERAL MEETING OF THE INSTITUTE OF MINING AND METALLURGY, THURSDAY, OCT. 19, 1922.

THE 'DAVON' MICRO-TELESCOPE AND SUPER-MICROSCOPE.

By F. Davidson.

Mr. Davidson said that the apparatus which he had the pleasure of introducing marked a step in progress towards utilising the microscope in a variety of ways which had hitherto been rather unassociated with it. There was nothing really revolutionary about it, although they brought the telescope, as it were, almost into microscopic uses and the microscope somewhat into telescopic uses. The two instruments, of course, had each their special field of utility, the telescope dealing with distant objects and the microscope with near objects, but by certain additions to the microscope the gap between the two instruments was bridged. That, he thought, he would be able to demonstrate to the members.

The principle involved in the apparatus, to take the micro-telescope first, was the application of a short-focus telescope-objective in a tube with a series of diaphragms to the microscope, the microscope itself acting as a compound eye-piece. With that attachment, which contained a 6-in. telescope-objective inserted into the 'Abbé' rim of the microscope, there was an image of a distant object projected to the plane of the stage and that air image was magnified by the microscope proper, and, as a result, objects could be seen as near as 6 ft. Its range was practically from 6 ft. to infinity. One could then, for example, view the scales of barometers or thermometers at any distance, inaccessible parts of the machinery and certain parts of a mine, provided, of course, that the light could be projected on to the object. Rock *in situ* could be examined. Distance practically did not affect it. But above all, the chief characteristic of the observations one got was depth of focus. One could look at an ordinary photograph with that instrument and see it in apparent stereoscopic relief. That was rather a large statement to make, but members would believe the evidence of their own eyes.

The idea of employing a telescope-objective on a microscope was not a new one. He remembered when he first introduced it, quite a controversy raged in the pages of a certain journal, and one gentleman said he had tried it forty years previously, but it was no good. His reply was that because Tom did not succeed it was no reason why Harry should not. The fact remained that they had a micro-telescope which was capable of being used in a variety of ways and for a variety of purposes for which the orthodox telescope could not be used. Members would have an opportunity—perhaps some had already had it—of looking through the telescope at a bird's nest which was photographed with the micro-telescope, by a doctor in Ireland, at a distance of 50 yards.

Next, they had an attachment of shorter focus with which they did some rather remarkable work in regard to objects which, because of their sibe or shape, could not be put upon the stage of a microscope—minerals, especially metal fractures, and material of various kinds on which there were various planes which could not be brought into focus with an ordinary microscope. The observation of a piece of coral and a transverse fracture of aluminium alloy would be seen, and those who would look through the instrument would be struck with the extraordinary depth of focus thus obtained. A variation of magnification of from 30 diams. to 90 diams. was possible without altering anything but tthe distance from the object. Even at the higher magnification the relative depth of focus was always maintained. He could not, of course, state all the uses to which such an instrument could be applied, but no doubt there were directions in which its application would be at once apparent to most of the members. But, as far as they had been able to utilise it themselves, it had been agreed by men connected with various industries that it opened up a new field of observation.

Then, coming to the third attachment, when it was put on to the microscope it carried the system of direct observation very much further. There was another tube in which they placed a microscope-objective at one end. At the other end of the tube was another achromatic combination which he called a collector, and then they had what he called the super-micro-

scope. The word 'super' was perhaps not wisely chosen. To him it was a curtailment of the word 'superior,' but many had thought that it meant nothing else but *super-magnification*. Well, it did not mean anything of the kind. However, that was what he called it—the super-microscope. By means of the collector the image of a microscopic object was projected at some distance beyond it. The position of the air image which was projected depended upon the distance that the collector happened to be from the front or primary objective. That enabled them to carry that system of direct observation which was begun with the short-focus attachment up to pretty nearly 1,000 diams. and still have sufficient working distance to illuminate an object from above.

He remembered once giving a demonstration at Leeds University, and mentioning that, and one of the professors brought a scale from bis pocket of $\frac{1}{100}$ mm., and requested him to show that under such conditions. The professor was very agreeably surprised when he showed him that, under a magnification of 1,000 diams., every line on the scale stood up like a fence, and he immediately said that it opened up possibilities. As they would be aware, the working distance under high maginfication of the ordinary microscope was a very small one. One could, with that system, for that particular class of work go to very nearly 1,000 diams. and have a $\frac{3}{4}$-in. working distance.

He did not want them to believe that he meant that they could examine critically etched-metal specimens or anything of that kind. He had been called over the coals for venturing the remark that there were two kinds of microscopy, critical and non-critical. It had been said, "We only recognise one kind of microscopy, which is *critical* microscopy," to which he replied that examination microscopically under comparatively low power of a piece of metal or a piece of mineral could not be in the same class of observation as looking under a magnification of 1,000 or more at an etched-metal specimen where the *structure* was required to be observed. But he thought for certain classes of observation the facility of being able to make observations under a fairly high magnification with sufficient distance to illuminate the object from above certainly opened up some possibilities; in fact he knew it did in certain directions.

When they came to critical work the structure of the super-microscope was altered. For a long time they could not find anyone who would even look at the super-microscope. They were so convinced that it was all wrong—of course it was horribly unorthodox, he knew—that nobody would look at it. He was speaking now of the bacteriological side of it just for the purpose of explaining the position. The position that he took was that, unorthodox as it was, the super-microscope was still capable of performing critical work, in addition to the many other uses to which it could be applied. For example, with a 4-in. objective as the primary, and a 1-in. as the secondary, one could obtain a variation of magnification of from 80 diams. to 180 diams., and have a working distance of 5 in. at the lower magnification and 2 in. at the higher, with all the attendant advantages of field and depth of focus. It remained for a doctor eventually to approach the subject with an unbiassed mind, and to find out whether he was right or wrong. After prolonged experiment the doctor came to the conclusion that if the whole of the super-microscope arrangement was placed above the stage of the microscope and not, as it was before then, partially below it, then a one-sixth objective would do all that a one-twelfth would do except for the very highest critical research work.

The doctor made very severe tests upon the granules of leucocytes, and he was able to say that he could go to a magnification of about 1,300 with a one-sixth objective before resolution began to fail. That was a very high magnification to put on a one-sixth objective. It really went against all accepted laws or rules upon the subject, but the fact remained that it could be done.

When that point had been decided, they built the super-microscope as they had it befor ethem, in which the whole of the structure was above the stage. The collector was above the microscope O.G., and then there came the microscope proper. The magnification was varied by altering the distance between the microsuope-objective and the collector. There was the usual fine focussing of the microscope, and also the means for moving the eye-piece and objective of the secondary microscope in order to focus the air image. As a result of that, they were able to say definitely, that although they had interfered with the principles upon which the microscope was constructed, and the principles upon which the

objective was constructer, the results remained good.

A criticism which had been made was that one dared not interfere with the tube length for which a microscope objective was constructed, and the fact that they did intefrere with it or ignored the question of tuve length would be fatal. But the fact remained that it was not fatal. A critical image could be obtained with the super-microscope just as well as with an orthodox microscope. However, the broad claims which were made for the apparatus, generally speaking, were that the gap between the microscope and the telescope was bridged, and that with the super-microscope they appeared to be able to utilise a higher magnification than was usually employed upon an objective without losing the resolution. He did not wish it to be thought that he was claiming to give bigher resolution by means of that higher magnification. Neither he nor anybody else could give a higher resolving power than the primary microscope-objective was capable of giving, but without losing that resolving power they did appear to be able to utilise a higher magnification upon that objective.

The other point he would like to bring to their notice was the fact that anything that could be seen with either piece of apparatus could be photographed by it by simply ermoving the body tube of the microscope and *substituting a camera*. They had photographed all sorts of things at all sorts of distances, and he would have the pleasure of showing some of them upon the screen directly. But let them take this, for example; they were able to use the same lens for tele-photography as for observation, and some very remarkable tele-photographs had been taken. With a short attachment they had photographed metal fractures and things like that, and with the super-microscope they had photographed things from life-size to diatoms under a magnification of 3,000 diams.

HISTORY OF SOAP.

BRISTOL'S SHARE IN GREAT INDUSTRY.

Lecture by Mr. E. Lewis, F.I.C.

A meeting of the Co-Partners' Cluh of Messrs. C. Thomas and Bros., Ltd., soap manufacturers, Bristol, was held at Broad Plain Hall, Bristol, last week, when Mr. T. A. Glass presided over a very large attendance of members and friends.

An illustrated lecture on "Soap and Glycerine Manufacture" was given by Mr. E. Lewis, F.I.C., chemist to Messrs. C. Thomas and Bros., Broad Plain, and dealt particularly with the early history of soap making, referring to the antiquity of the industry in Bristol, modern methods of seed crushing for oils used in the soap industry, together with the modern methods of soap manufacture and the recovery of glycerine as a product. Mr. Lewis said that in its broadest sense soap is a compound of a fat, or, more correctly, a fatty acid with a base, and is produced by the action of alkalies, such as soda or potash on tallow, coconut oil, or olive oil. Other soaps are known, such as that of ammonia used in dry cleaning, that of lead used in pharmacy, and zinc soaps used in the oil and paint industry. Commercially it is customary to restrict the term soap to soda, potash, and ammonia soaps. Dealing with the early history of soap, it was stated that no record exists of its discovery, but it appears to have been an ancient art, and in a large measure an ordinary household process, the product being a mixture of goat's tallow and the liquor obtained on leaching wood ashes. The lecturer stated that a large use had been made, and is still used in isolated areas, of natural products as detergent agents. The Romans used Fuller's earth to a considerable extent, as it possesses the property of absorbing grease when stamped into cloth and removed by subsequent scouring. Even up to the beginning of the 18th century this system was practised in Rome.

EARLY SOAPS.

Soap is first mentioned in 630 B.C., but this appears to be a reference to detergents, such as the roots of various plants which possess the property of forming a lather when rubbed on the wet skin or clothes. Jewish history records the use of a certain herb called "borith," which word is translated soap in the English version of the Bible. The Indians of Mexico and certain portions of California use even to-day the roots of the Amole plant and seeds of the Sapindus tree (soap berries) for cleansing purposes. In tropical countries the fruit and bruised leaves of the soap wort plant are used, which contains the chemical Saponine; this is contained to a small extent in the English horse chestnut.

In Chili, the inner bark of the Quillac tree, after reducing to powder, is used as a substitute for soap. In the first century mention is made of soap by Pliny, and Geber in the second century refers to the use by physicians of lead soaps as an ingredient of plasters. During the excavations at Pompeii the remains of what was apparently a soap-making establishment has been discovered. The Germans were acquainted with a crude method of soap manufacture in the 7th century, the Italians in the 8th, and the 10th century saw its manufacture established on a commercial scale at Marseilles, a city which became celebrated for the quality of its product. This city was favourably located, since it was in the centre of the olive oil producing region, and the sea coast furnished the seaweed from which the alkali was made. In England up to the 14th century there were no regular establishments devoted entirely to soap manufacture; the greater portion was made in a crude way domestically, and used principally for fulling cloth.

THE INDUSTRY IN BRISTOL.

In 1624 Charles I. formed a monopoly of the industry to a Corporation of London soap-makers. A few years later Bristol, in consideration of a heavy payment, was allowed to make 600 tons a year, a small quantity in comparison with the then normal output. The 18th century files of the Bristol newspapers contain advertisements by the Bristol Soapmakers offering rewards for information of attempts to break the soap monopoly. Soap making appears to be a very old Bristol trade; it is mentioned by Richard of Devizes, who lived towards the end of the 12th century. In the Middle Ages large quantities of Bristol soap were sold in London. In 1523, says a local authority, Bristol supplied London with the best grey speckled soap, or ye grey mottle. The trade was certainly in a flourishing state at the end of the 16th century ,as we owe one of our finest schools to the prosperity of the trade at that time. It is well-known that the Queen Elizabeth School, better known as the City School, was founded by John Carr, a soap-maker, who bequeathed a house and 50 acres of land in the parish of Siston, 15 acres of land at Stowick, in the parish of Henbury, and a house in Host Street, Bristol. In 1711 an Excise duty of 3d. a lb. was imposed on all soap made, a tax which was not repealed until 1853, when the soap manufactured in this country amounted to 100,000 tons. Last year the soap produced in this country is estimated at 300,000 tons.

Mr. Lewis showed some excellent lantern slides of primitive and modern methods of seed crushing for soap oils and fats, modern methods of soap manufacture, glycerine evaporation and recovery plants, the whole being well illustrated by line drawing lantern sketches. The chemical operations were illustrated by some ingeniously devised diagrams, which showed much originality and ingenuity. The lecture concluded with a number of experiments conducted before the lantern, showing the varying thickness of the walls of a soap bubble, and the tension of soap films in various geometrical figures and spirals, in the form of wire frames. A well-arranged exhibit of soap-making materials was shown during an interval, the whole being arranged in sequence, from the stage of the nuts in their native state to that of the finished soap and glycerine.

The lecturer expressed thanks to Mr. Walls and Mr. Fraser, directors of the company, for providing the slides and granting every facility in the preparation of the lecture and exhibits.

CYPRINE AND ASSOCIATED MINERALS FROM THE ZINC MINE AT FRANKLIN, N.J.

BY J. VOLNEY LEWIS AND LAWSON H. BAUER.*

The following notes refer chiefly to cyprine, the sky-blue variety of vesuvianite, in intimate microscopic mixture with willemite, and to the associated rhodonite (var. bustamite) and andradite (var. polyadelphite).

1. *Vesuvianite, var. Cyprine.* — Bluish green fibrous cyprine was found in granite in the Parker shaft, at Franklin, in 1905, and was described by Professor Palache,[1] who also published the analysis by Steiger, which is quoted below for comparison.

The mineral here described was found in the ore body near the hanging wall in a crosscut 374.5 feet south and 361.5 feet west of the Parker shaft, and 10 feet above

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* *The American Journal of Science*, September, 1922.

[1] *Charles Palache: Contributions to the Mineralogy of Franklin Furnace, Amer. Jour. of Science*, 1910, (4), XXIX., 184.

the 80-5foot level. It is sky-blue in colour; in texture it varies from fine granular and fibrous to dense. To the naked eye, and even under the hand lens, it appears to be homogeneous. The analysis (A, below) showed nearly 22 per cent. zinc oxide, and since the oxide ratios fell within the limits of variation of vesuvianite, it was supposed that a new variety of this mineral had been found.

Thin sections showed, however, that while vesuvianite is the dominant mineral, it is plentifully sprinkled with rounded grains and hexagonal crystals of willemite, with dimensions up to 0.16 mm. in diameter. Measurements by the Rosiwal method showed that this mineral constitues 29 per cent. of the volume, or 33.3 per cent. of the mass. If the zinc, iron, and manganese of the accompanying analysis (A) are assigned to willemite, the calculation gives 32.68 per cent. of this mineral. The remaining constituents, calculated to 100 per cent., represent approximately the composition of the vesuvianite. A few minute particles of metallic copper were visible under the microscope, but doubtless most of the copper determined is in combination.

The analysis of this mixture and the results of the calculations are given here, together with Steiger's analysis[2] of cyprine from the Parker shaft.

Analyses of vesuvianite from Franklin, New Jersey.

	(A)	(B)	(C)	(D)
SiO_2	32.42	8.70	35.14	36.41
Al_2O_3	14.07		20.86	17.35
FeO	0.77	0.77		1.86
MnO	1.50	1.50		1.75
ZnO	21.71	21.71		1.74
CuO	0.99		1.47	1.48
CaO	25.22		37.40	33.21
MgO	1.08		1.60	1.38
H_2O	2.38		3.53	(−0.24
				(+3.51
Others	—	—	—	1.15a
	100.14	32.68	100.00	100.08

A.—Vesuvianite-willemite mixture, apparently homogeneous. L. H. Bauer, analyst.

B.—Willemite calculated from A.

C.—Remainder of A, recalculated to 100 per cent.—approximately the composition of the vesuvianite.

D.—Steiger's analysis of vesuvianite from the Parker shaft. Sp. gr. 3.451, care-

Analyses of bustamite from Franklin, N.J., and Langban, Sweden.

fully freed from specks of metallic copper.

2. *Rhodonite, var. Bustamite.* — Pale pink in colour; elongated cleavable to coarsely fibrous in texture. Calcium replaces manganese to a remarkable degree, as shown by the analysis (E), by L. H. Bauer ,with which is compared (F) the mineral from Langban, Sweden, as given by Dana (System of Mineralogy, p. 380):

	(E)	(F)
SiO_2	46.72	47.66
Al_2O_3	1.34	
FeO	0.46	0.48
MnO	26.51	31.65
ZnO	1.34	
CaO	22.24	18.16
MgO	1.27	1.18
Others		0.98b
	99.88	100.11

3. *Andradite, var. Polyadelphite.* — The brown granular garnet associated with the vesuvianite approaches typical andradite in composition (analysis G, by L. H. Bauer) more nearly than the specimens from Franklin repersented by the older analyses, (H)and (I), quoted by Dana:

Analyses of Andradite from Franklin, N.J.

	(G)	(H)	(I)
SiO_2	34.28	34.83	33.72
Al_2O_3	3.12	1.12	7.97
Fe_2O_3	25.53	28.73	17.64
MnO	7.41	8.82	16.70
CaO	29.20	24.05	25.88
MgO	0.39	1.42	(Ign. 0.08)
	99.93	98.97	101.99

Besides the minerals named above, brown and reddish brown phlogopite is also abundant in scales and crystals, and in places coarse cleavable feldspars. Some of the latter give extinction angles corresponding to labradorite and others to anorthite. There are also very rare grains of pyrite, a small amount of cleavable calcite, and a little dark green pyroxene.

October 26, 1921.

[2] *U.S. Geol. Survey, Bulletin,* 1915, MXCI., 315. *This statement of Steiger's analysis, which is followed here, differs slightly from that given by Professor* [illegible]

a PbO tr.; Na_2O 0.44; K_2O 0.50; F 0.36; less O = F 0.15.

b BaO 0.19; alkalis 0.27; gangue 0.52.

POTASSIUM AZIDO-DITHIO-CARBONATE.[1]

By A. W. Browne and A. B. Hoel.
(*With Notes on Crystallography by A. C. Gill.*)

[Contribution from the Department of Chemistry of Cornell University.]

(*Continued from Page 349.*)

Decomposition.—The azido salt is rather sensitive to shock. Dry crystals have repeatedly been broken in an agate mortar, but during this operation several samples have exploded with violence. The explosion experienced by Sommer on rubbing the moist crystals upon a porous plate was undoubtedly due to the sensitising action of the sharp edges of the plate.

When heated slowly in a capillary melting-point tube, the crystals began to decompose at about 126°, with evolution of gas. When heated rapidly upon an iron plate, the substance detonates with a sharp explosion, but less violently than do the heavy metal trinitrides. Slow thermal decomposition of potassium azido-dithiocarbonate takes place quantitatively in accordance with the equation

$$KSCSN_3 = KSCN + S + N_2 \qquad (1)$$

Samples of the azido salt weighing 0.1296 and 0.1495 g. held at 100° for about 50 hours in a nitrometer tube yielded 17.64 and 19.01 cc. (corr.) of nitrogen, correspodnin gto 1.91 and 1.90 atoms of nitrogen per molecule of the salt. Titration of the aqueous extract of each residue with standard silver nitrate solution showed the presence of 0.0793 and 0.0869 g. of potassium thiocyanate, or 0.99 and 1.00 molecule of this substance per molecule of azido salt.[4]

The final residues obtained after the extraction consisted of 0.0237 and 0.0245 g. of free sulphur, corresponding to 0.90 and 0.86 atoms of sulphur per molecule of the salt. The low values for sulphur are attributable to unavoidable loss of small amounts of that substance by sublimation during the long period of heating in the nitrometer.

When the azido-salt explodes in the open air a spectacular flame is produced, with liberation of much heat and formation of numerous products. Samples of the compound weighing 0.2 g. and held in a deflagrating spoon suspended in the centre of a 12-litre Pyrex glass flask were detonated by means of an electric spark. The presence of sulphur dioxide, carbon dioxide, hydrogen sulphide, sulphur trioxide, free sulphur, and potassium thiocyanate as products of the decomposition in addition to nitrogen was established. The principal reaction may therefore be expressed by the equation,

$$2KSCSN_3 + 5O_2 = K_2S + 3SO_2 + 2CO_2 + 3N_2 \qquad (2)$$

although a part of the sample undoubtedly decomposes in accordance with Equation 1.

Aqueous solutions of the azido salt are quite stable at temperatures of 10° or lower, as is also the dry salt itself. At somewhat higher temperatures, however, the aqueous solutions gradually become turbid, with separation of sulphur, liberation of nitrogen, and formation of potassium thiocyanate. A solution obtained by dissolving 0.187 0g. of the salt in 10 cc. of water, and held in a Lunge nitrometer at 20-25° gradually became turbid, and liberated in 16 days 2.44 cc. (corr.) of nitrogen. Samples of the dry salt stored in the desiccator at room temperatures gradually turn yellow, owing to the separation of sulphur.

When a solution of the azido-salt was subejcted to distillation thiocyanates were obtained in the residue, but no appreciable quantities of cyanides, sulphides, sulphites, carbonates, trinitrides, or of ammonia were ound in either distillate or residue. When 15 cc. of an approximately 20 per cent. solution of the azido salt was mixed with an equa lvolume of 6 *N* potassium hydroxide solution, and distilled until half of the volume had gone over, thiocyanates were found in the residue. With 6 *N* sulphuric acid in place of the alkali, both thiocyan

[1] *The investigation upon which this article is based was supported by a grant from the Heckscher Foundation for the Advancement of Research, established by August Heckscher at Cornell University. The present paper is Article No. 3 under Heckscher Grant No. 4. For Articles* 1 *and* 2 *see Jour. Amer. Chem. Soc.*, 1922, XLIV., 2106 *and* 2116.

[4] *In connection with certain of the earlier experiments the presence of potassium thiocyanate among the products of decomposition of the azido salt was established by microchemical tests performed by Professor E. M. Chamot, of whose work the authors desire to express their appreciation.*

ates and sulphides were found in residue and distillate. In a blank experiment with potassium thiocyanate and sulphuric acid similar results were obtained. In no case were cyanides, sulphites, carbonates, trinitrides, or ammonia detected.[5]

Small amounts of a solution of potassium azido-dithiocarbonate were added to aqueous solutions of silver, mercurous, mercuric, bismuth, cupric, cadmium, aluminium, chromium, nickel and cobaltous nitrates; ferrous, ceric, zinc, and thallous sulphates; stannous, and manganous chlorides ;lead, and cupric acetates, and qualitative observations were made which, in the main, corroborate the work done by Sommer with a solution of the sodium salt, in investigating the properties of the azido-dithiocarbonate ion.

Solutions of potassium azido-dithiocarbonate, when treated with certain oxidizing agents yield a white precipitate of azido-carbondisulphide, $(SCSN_3)_2$. It was found by Sommer that solutions of (a) iodine in potassium iodide, (b) ferric chloride, (c) potassium permanganate, potassium dichromate ,and ceric salts in presence of sulphuric acid, behave in this manner. These results have been confirmed by the authors,[6] and additional oxidizing agents, including potassium persulphate, hydrogen peroxide, bromine water, chlorine water, as well as sodium nitrite, manganese dioxide in sulphuric acid solution, and stannic chloride in hydrochloric acid solution, have been found to react at room temperature with solutions of the azido salt, precipitating azido-carbondisulphide. Potassium iodate reacts slowly, after standing for several hours, while ozone yields no precipitate whatever. Anodic oxidation of the azido salt in aqueous solution readily yields azido-carbondisulphide.

Structure. — The fact that potassium azido-dithiocarbonate decomposes quantitatively when gently heated, into potassium thiocyanate, sulphur, and nitrogen affords almost conclusive proof of the correctness of the structure assigned by Sommer to salts of azido-dithiocarbonic acid. If the correctness of the Angeli-Thiele-Turrentine formula for hydronitric acid be assumed, the structure of potassium azido-dithiocarbonate is as follows: $K—S—C(=S)—N=N\equiv N$.

[5] *These and certain other qualitative tests, connected with the present investigation, were performed by Miss Hazel E. Braman, to whom the authors wish hereby to express their gratitude.*

[6] *In connection with this work the authors acknowledge with pleasure the assistance rendered by Mr. A. L. Satterth-*

SUMMARY.

1. Potassium azido-dithiocarbonate, found by analysis to have the formula $KSCSN_3$, may be prepared by the action of carbon disulphide upon potassium trinitride in aqueous solution.

2. The colourless, unstable, deliquescent crystals of this azido salt decompose quantitatively when gently heated, yielding potassium thiocyanate, sulphur and nitrogen, or explode when rapidly heated, with formation of potassium sulphide, carbon dioxide, sulphur dioxide and trioxide in addition to these products.

3. Solutions of the azido salt when treated with various oxidizing agents, or when subjected to electrolysis, yield azido-carbondisulphide, $(SCSN_3)_2$.

ITHACA, NEW YORK.

—From the *Journal of the American Chemical Society*, Sept., 1922.

PROCEEDINGS OF SOCIETIES.

THE ROYAL SOCIETY.

ORDINARY MEETING, NOVEMBER 23, 1922.

Sir Charles Sherrington, President, in the Chair.

The following papers were read, the summaries here printed having been supplied by the authors for use at the meeting:

DR. T. E. STANTON, F.R.S.: *On the Characteristics of Cylindrical Journal Lubrication at High Values of the Eccentricity.*

The paper describes the results of experiments on cylindrical journal lubrication, in which the arc of contact of the film is limited in extent and the intensity of pressure is considerably higher than in normal practice. The extent of the arcs of contact has varied from 14 to 35 degrees and the maximum intensities of pressure from 1.4 to 3.5 tons per sq. inch. In all the cases observed it has been found that the pressure distribution in the film has been in accordance with the hydrodynamical theory laid down by Osborne Reynolds.

By means of a careful determination of the pressure distribution in the film, and a measurement of the radius difference of bearing and journal, sufficient data have been obtained to calculate the viscosity of

the lubricant and the attitude and eccentricity of the bearing without the necessity of an integration of the hydrodynamical equations of motion.

The values of the viscosity of the lubricant so calculated were found to be in good agreement with those independently determined in a viscometer, and it was concluded that the calculated values of the eccentricity were reliable. In the case of a journal 2.5 cms. diameter, the least distance apart of the surfaces was found to vary from 0.0012 to 0.0024 mm.

J. H. Jeans, Sec. R.S.: *The Propagation of Earthquake Waves.*

The free vibrations of a non-homogeneous gravitating earth are investigated, and earthquake waves are regarded as being compounded of a number of such free vibrations.

In 1885 Lord Rayleigh discussed a certain type of surface waves which would travel over the earth's surface with a velocity of about 0.92 $\sqrt{(\mu/\rho)}$. It is now shown that there are additional, and far more numerous, surface waves which travel with velocities $\sqrt{(\mu/\rho)}$ and $\sqrt{((\lambda+2\mu)/\rho)}$. If such waves are generated by an earthquake at any point close to the earth's surface, they will refocus themselves upon this point after intervals which are integral multiples of $2\pi a\sqrt{(\rho/\mu)}$ and $2\pi a\sqrt{(\rho/(\lambda+2\mu))}$, the numerical values of these quantities being about 223 and 126 minutes respectively.

In 1917, two series of earthquakes, each originating from the same centre, had their times given approximately by formulæ of the type—

$t = t_0 + n_1 \times 125.8 + n_2 \times 222.0$ minutes.

The question is raised whether it is possible that the return waves sent out by one shock may produce a second shock by a kind of "trigger" action.

Prof. F. A. Lindemann, F.R.S., and G. M. B. Dobson: *A Theory of Meteors and the Density and Temperature of the Outer Atmosphere to which it leads.*

Formulæ are derived for the head-resistance and heating of a particle moving through the air at a speed great compared to that of sound.

It is shown that all major meteoric phenomena can be accounted for consistently if the luminosity of the meteor is attributed to the collision of volatilised meteoric vapour with the air molecules.

From observed meteoric data the density of temperature of the air at great heights is derived in four independent ways which give results consistent with each other.

The density above 60 km. appears to be very much greater than corresponds to an isothermal atmosphere at 220° Abs., and the temperature appears to be in the neighbourhood of 300° Abs. A tentative explanation is put forward to account for such a high temperature based on the radiative properties of ozone.

Prof. F. C. Thompson and E. Whitehead: *On the Changes in Iron and Steel at Temperatures below* 280° *C.* Communicated by Prof. H. C. H. Carpenter, F.R.S.

1. Iron shows abnormalities of rate of increase of electrical resistance and electric potential against platinum at well-marked temperatures. Below 280° C. these temperatures are: 55, 100, 120, 140, 220 and 245. Of these those at 120 and 220° C. are the most important. It is difficult to believe that these can be of the nature of allotropic changes, and for the time the explanation must be taken as unknown.

2. Under the same conditions carbide of iron posses two well-marked points at 160 and 200° C. It is not clear whether htese are distinct points, or are the ends of a single transformation range.

3. The etching of cementite has been studied. Broadly the reagents which darken cementite are strongly alkaline. No acid and only one neutral solution will do this. A solution has been discovered which will enable the two forms of cementite to be differentiated micrographically, but since β-cementite will change to the a form in a few days at room temperature, this etching is not always satisfactory.

4. When samples of iron and high carbo nsteel are quenched from 280° C., it is found that the electrical resistivities differ fro mthose obtained by slow cooling. These values are not constant, but as the material tempers they gradually alter, till after the lapse of some days the values practically coincide with those obtained by slow cooling.

C. F. Jenkin: *The Fatigue Failure of Metals.* Communicated by Sir Alfred Ewing, F.R.S.

The paper contains a theory of the mechanism of fatigue failure in metals which explains all the principal phenomena observed in connection with fatigue tests on metals. The theory is demonstrated by means of a simple model which possesses the assumed properties of the crystals

forming the metal. The model, when tested like a metal test-piece, gives stress/strain curves, hysteresis loops, and the complete series of fatigue ranges of exactly the same character as those given by the metal test-piece.

The truth of the theory can be tested in many ways, and experiments are described which have been made for this purpose. Sugegstions for further experiments are given: a method of mechanically treating a mild steel test-piece is described, which, according to the theory, should raise its fatigue range about 20 per cent.; another treatment is described which should lower the fatigue range of medium steel by about 25 per cent.

The theory suggests many new lines of investigation.

Prof. S. Brodetsky: *The Line of Action of the Resultant Pressure in Discontinuous Fluid Motion.* Communicated by Sir George Greenhill, F.R.S.

The general solution of the problem of discontinuous fluid motion past any barrier can be expressed in terms of the variable introduced by Levi-Civita, by means of which the part of the barrier in contact with the moving fluid is transformed into a semi-circle. The form of the barrier is defined by the coefficients in a Taylor expansion.

Although the components of the resultant pressure on the barrier have been calculated in terms of these coefficients, the line of action has not been ound, and the object of this communication is to supply the deficiency. The amount of the resultant pressure about a certain point is proved to be a simple function of the first four coefficients fo the above expansion, and it is shown how to use the result in actual problems.

Dr. R. A. Houstoun: *An Investigation of the Colour Vision of 527 Students by the Rayleigh Test.* Communicated by Prof. A. Gray, F.R.S.

Lord Rayleigh discovered in 1881 that if homogeneous yellow is matched with a mixture of homogeneous red and homogeneous green, some persons require much more red, others much more green in the mixture than the normal. Such persons have been called "anomalous trichromats."

The present paper describes a survey made with an apparatus similar to Rayleigh's and embracing a much greater number of observers. The results are exhibited in the form of frequency curves.

In the case of the 104 women the frequency curve is almost a perfect case of normal variation; in the case of the men the normal curve is present, and outside of it lie the colour blind and the anomalous trichromats; but the anomalous trichromats are much fewer in number than would be expected from Rayleigh's original paper.

THE ROYAL SOCIETY.

Thursday, December 7, 1922, at 4.30 p.m.
Papers read:—

Lord Rayleigh, F.R.S.: *Spectrum of Active Nitrogen as affected by Admixture of the Inert Gases.*

G. H. Henderson, Ph.D.: *Changes in the Charge of an α-Particle passing through Matter.* Communicated by Sir Ernest Rutherford, F.R.S.

W. T. Astbury: *The Crystalline Structure and Properties of Tartaric Acid.* Communicated by Sir William Bragg, F.R.S.

J. N. Mukherjee: *Sources of Error in the Measurement of the Electrical Charge of Colloidal Particles by the Method of Moving Boundaries.* Communicated by Prof. F. G. Donnan, F.R.S.

J. Heyrovský: *The Significance of the Electrode Potential.* Communicated by Prof. F. G. Donnan, F.R.S.

A. M. Mosharrafa: *On the Quantum Theory of the Simple Zeeman Effect.* Communicated by Prof. O. W. Richardson, F.R.S.

S. Brodetsky: *Discontinuous Fluid Motion past Circular and Elliptic Cylinders.* Communicated by Prof. G. H. Bryan, F.R.S.

THE CHEMICAL SOCIETY.

Lecture.

On Thursday, December 14th, 1922, at 8 p.m., at the Institution of Mechanical Engineers, Storey's Gate, S.W.1, Professor Cecil H .Desch, D.Sc., Ph.D., will deliver a Lecture, entitled: "*The Metallurgical Applications of Physical Chemistry.*"

PHYSICAL SOCIETY OF LONDON.

A meeting of the Society was held at 5 p.m. on Friday, December 8, 1922, at the Imperial College of Science, South Kensington, S.W.

AGENDA.

1. *The Relation between Molecular and Crystal Symmetry as shown by X-ray Crystal Analysis*, by G. SHEARER, M.A., B.Sc.
2. *Modification of the Powder Method of Determining the Structure of Metal Crystals*, by E. A. OWEN, M.A., D.Sc., and G. D. PRESTON, B.A.
3. *The Cathode Ray Oscillograph*, by A. B. WOOD, D.Sc.

A demonstration of a "Low Voltage Cathode Ray Oscillograph" was given by the International Western Electric Company.

PROCEEDINGS AT THE MEETING HELD ON NOV. 24, 1922, AT THE IMPERIAL COLLEGE OF SCIENCE.

Alexander Russell, M.A., D.Sc., in the Chair.

A paper on *The Theory of the Singing Flame* was read by Mr. E. G. RICHARDSON, B.Sc.

Abstract.

The various theories of the action of the Singing Flame put forward since its discovery are reviewed, and experiments to test the relative merits of the two most recent theories are described; Lord Rayleigh's theory is shown to fit the results most closely, in that (1) heat is given by the flame to the air in the tube at each condensation, and (2) stationary waves are formed in the gas as well as in the air-tube. But the lengths of gas-tube unfavourable to the "singing" cover, in fact, a much more restricted range than Lord Rayleigh surmised.

A paper on *Unit Surfaces of Cooke and Tessar Photographic Lenses* was read by MISS ALICE EVERETT, M.A.

Abstract.

A number of rays in an axial plane (and a few general rays) are traced through the lens systems by exact methods, and on each ray the positions of the conjugate points for unit magnification are found by Mr. T. Smith's formulæ. The results show that for general rays the loci of these "unit points" are three-dimensional. The loci are surfaces only when the chief rays are bound by some condition such as passing through a fixed point of the object. In this case the unit surfaces are not fixed, but shift with the object point. The curvature varies with aperture, and with the distance of the object point from the optic axis. Hence the unit surfaces cannot coincide with wave-fronts. Within the region for which the lenses are designed, the curvature of both object and image unit-point loci is positive (convex to the light source) and the image locus is more curved than the object locus. These facts do not coincide with the theoretical conclusions obtained by Mr. Smith for either a thin system or an ideal thick system, but accord more nearly with the latter, especially as regards the sign of the difference of curvatures of the two unit surfaces.

A paper on *Vibration Galvanometers with Asymmetric Moving Systems*, by R. LL. JONES, M.A., was taken as read.

Abstract.

In the theory of the vibration galvanomete rwith one degree of freedom certain specified conditions are assumed to hold. If these conditions are not satisfied in a galvanometer, the instrument will show multiple resonance. This indicates the need of a more general theory. The theory of vibrations of a system with two degrees of freedom is briefly given, expressions for the amplitudes of the forced vibrations are deduced, and the conditions for resonance ascertained. The results are applied to a galvanometer in which the moving system is asymmetrically hung on a laterally yielding axis, and it is shown that the formula for the amplitude is capable of reproducing with fair accuracy the sensitivity curve of the galvanometer, which shows multiple resonance. Asymmetry always lowers the sensitivity of the resonance, and the loss can be ascertained by the help of the sensitivity curve. The analogy to the vibrations in coupled circuits is pointed out.

I wish to express my gratitude to A. Campbell for helpful criticism, advice and references.

A Demonstration of *Some Applications of the Gyroscope* was given by M. PAUL SCHILOWSKY, Chairman of the Gyroscopic Society, Petrograd.

M. Schilowsky said that the principles of the gyroscope are insufficiently taught in technical colleges, with the result that the subject has received very little attention from the engineering profession. Engineer

are in consequence unduly sceptical as to the applicability of such principles to practical problems, although a staff of some 50 Russian experts, under the speaker's chairmanship, had evolved designs for the construction of a perfectly safe and practicable monorail system for a suburb of Petrograd. The models he was exhibiting were not to scale. In practice the gyrostatic apparatus would form from 3 per cent. to 5 per cent. of the load of a ship, and from 5 per cent. to 10 per cent. of the load of a monorail carriage. The underlying principle of his invention is as follows: To stabilise a system in unstable equilibrium, a reaction must be set up between the system and the gyorstat of such a character as to *help* the precession of the gyrostat during the return of the system to normal. To check the oscillations of a stable system, the reaction must be such as to *oppose* such precession. The gyrostat must, of course, be power-driven to neutralise friction. The exhibits included the following.

(*a*) A collection of apparatus for teaching purposes, comprising *inter alia* models illustrating the precession of the earth, a method of optically projecting an image of a spinning top, and small monorail models. The above-mentioned principle was illustrated by means of a top which, when spinning on a sharp point, exhibited precession. When, however, the point was furnished with a spherical knob, the top "slept" until its angular momentum was exhausted by friction, when it abruptly collapsed.

(*b*) Model of a rocking ship. The gyrostatic flywheel is mounted with its axle vertical in a frame, which can both rock about and slide along an axis transverse to tthe ship. When the ship rolls to starboard the axle of the wheel tilts in precession in a fore-and-aft plane, and at the same time the gyrostat slides bodily sideways under gravity, its frame engaging a rack which holds it with the axle in the tilted position. When the ship begins to roll back, the axle tries to reverse its fore-and-aft tilt, but is prevented by the engagement of the rack, which is spring-controlled. Thus precession is opposed during the return of the ship to normal and (the equilibrium being stable) rolling is checked by the resulting reaction.

(*c*) Model of an aeroplane carrying a gyrostat. The problem of combining automatic stability with mobility while avoiding dangerous stresses was discussed.

(*d*) Models of mono-rail gyrostatic appaartus. In the most recent design the flywheel is mounted with its axle vertical in a frame which can tilt in a fore-and-aft plane, and also slide sideways under gravity. The frame is surmounted by a pinion co-axial with and geared down from the flywheel; and the pinion lies between, but normally clear of, two parallel fixed racks mounted on the carriage, and having their lengths in a fore-and-aft direction. When the carriage tilts to one side, the axle of the flywheel tilts forward or backward in precession, and at the same time the gyrostat slides bodily sideways, so that the pinion engages one or other of the two fixed racks. The pinion then climbs back along the rack to its normal position—*i.e.*, in the same direction as the precession which it would exhibit during the righting of the carriage. Thus such precession is aided and (the equilibrium being unstable) the resulting reaction restores the carriage to the upright position.

(*e*) Angular-velocity indicator for aeroplanes. Angnlar velocity of the aeroplane about a vertical axis causes a tendency to precess in a goroscope rotating about an horizontal axis. This tendency is balanced by a gravity control, and the angle moved through in attaining a balance is indicated by a pointer, affording a measure of the required angular velocity.

An account of a *New Balance for Compensating the Temperature Error of Watches and Chronometers* was given by M. Paul Ditisheim, La Chaux de Fonds (Switzerland).

Abstract.

The Compensation Balance made from a bimetallic rim cut in two places has been for nearly two hundred years the only method used for equalising the rate of watches and chronometers in heat and cold. An entirely new system is now offered by the hairspring made of "Elinvar," an alloy invented by Dr. Ch. Ed. Guillaume, the elasticity of which is not affected by changes of temperature. Satisfactory timing can thus be obtained up to certain limits with a plain solid uncut balance. This metallurgic solution of the problem of compensation at all temperatures is an important step in the history of watchmaking.

In order to apply the "Elinvar spring" to higher grade watches a new compensation balance has been designed by M. Ditisheim. It is made from a plain monometallic uncut ring into which two very small symmetrical bimetallic blades are inserted

The latter will enable small corrections to be made in order to obtain very fine rates. This adjustment is necessary for compensating small differences between springs resulting from molecular change and mechanical treatment in their manufacture.

SOCIETY OF GLASS TECHNOLOGY.

An interesting ceremony took place in the early part of the meeting of the Society of Glass Technology, held on Wednesday, November 22nd ,in the Applied Science Department of the University of Sheffield, when the "Frank Wood" Medal was presented to the successful students in the Department of Glass Technology at the Sheffield University.

Mr. W. M. Gibbons, Registrar of the University, who attended on behalf of the University, said that they all liked to think that the Society of Glass Technology was born in the University, and they were glad at all times to welcome it in their midst. The University had a very warm regard for the study of glass technology.

In 1919 the Society decided to recognise the services Mr. Frank Wood had rendered in connection with its foundation, and handed over to the University a hundred guineas, with the condition that the income should be utilised to provide some reward to students in the glass technology department. It was decided that the reward should take the form of a medal, and that it should be associated with the name of Mr. Frank Wood, in whose honour it had been established. The medal had been designed by Mr. Percy Metcalfe, of the Royal College of Art, at the suggestion of Professor Rothenstein.

Mr. Frank Wood presented the medal to the successful students, Mr. G. G. Middleton and Mr. H. W. Howes, and in doing so expressed appreciation of the honour that had been done him by associating his name with the medal, and asserted that Dr. Turner had been the real backbone of the Society.

Prof. Turner gave a short account of a visit recently paid to Czecho-Slovakia, where he investigated the position of the glass industry and the methods of manufacture. After dealing with the difficult economic situation with which the Czecho-Slovakian glass industry has to struggle, Prof. Turner concluded by saying that "the technical side of the glass industry has not made anything like the progress that it has in this country. The Bohemian glass industry is living largely on its old tradition and the existing store of knowledge. Machinery scarcely exists for the mnaufacture of glassware, and the work is carried on largely by hand, as it was before the war. There was a great deal of money made in the industry in the boom years of 1919 and 1920, but very little of that money was put into the business to improve it. In this country we can look with some satisfaction to the fact that, despite E.P.D. taxes, British manufacturers put considerable sums into the improvement and extension of their works and in new plant, and—I am not without hope that the result of these improvements will mean that British manufacturers are able to make their goods cheaper and better. We can definitely say that, in many methods, from a technical point of view, we lead the European Continent at the present time, and I hope the result of that technical superiority will be evident before many months have passed.

A paper on the use of Selenium in the production of colourless glass, given by Mr. A. Cousen, A.R.C.S., was of great interest to both manufacturers and technical men present. Mr. Cousen gave details of a large number of experimental melts made to determine the effect of various batch materials on the decolourising power of selenium. Some unexpected and very interesting results were obtained. Details were also given of another series of melts in which the effect of the duration of melting on the colour developed was shown.

During the morning the members visited the works of the Parkgate Iron and Steel Co., Ltd., and took part in a very interesting tour of inspection.

GEOLOGICAL SOCIETY OF LONDON

At the meeting held on November 22n[d] Prof. Arthur Stanley Eddington, M.A., F.R.S., Pres. R.A.S., delivered a lectu[re] on *The Borderland of Astronomy a[nd] Geology*.

He considered first, in reference to ri[val] hypotheses as to the origin of the Ea[rth] and the solar system, the general evoluti[on] of the stellar universe. The trend [of] modern astronomy is against the view t[hat] luminous stars are being formed by co[lli]sions of extinct stars (unless very exc

tionally); the stars now observed have systematic relations one to the other, apparently indicating that they have been formed as the result of a single evolutionary process sweeping across the primordial matter. Collisions, in any case, would be extremely rare, since dynamical arguments indicate that extinct stars cannot greatly outnumber the observed luminous stars. Whether the original matter was gaseous or meteoric, it must have become entirely gaseous at a very early stage in the formation of a star: this is inferred from the fact that the masses of stars differ very little one from the other, and agree numerically with a certain critical mass, predicted theoretically for a sphere of gas, but unexplained if the star consisted of a swarm of meteorites. It is supposed that radiation-pressure was instrumental in breaking up the original matter into separate stars. These considerations favour the nebular hypothesis; but, if we accept Jeans's suggestion that the solar system is an exceptional formation, and that undisturbed stars cannot give birth to a planetary system, the argument is less cogent, since it refers only to stars developing normally. Astronomy now demands a great enlargement of Lord Kelvin's time-scale for the age of the sun; the most direct evidence is obtained from Cepheid variables, which are found to be developing at only 1/500 of the rate which Kelvin's hypothesis assumed. The sun must at one time have given out from 20 to 50 times as much heat as it emits now; but it is uncertain whether any geological strata go back to an epoch when the sun was sensibly hotter than now. Darwin's views on tidal evolution and the origin of the earth-moon system seem to have held their own against all criticism. The present rate of lengthening of the day (deduced from ancient eclipses) is about 1 minute in six million years; it is, therefore, difficult to date the birth of the moon later than 1,000 million years ago. There seems to be no objection to the postulate that the Earth had a cool solid crust at the time of the catastrophe, if that would explain geological observations; the Pacific Ocean may be the depression which was left, and may have received the waters which formerly covered most of the Earth. The dissipation of energy by the tides occurs chiefly in the land-locked shallow seas, G. I. Taylor having shown that the Irish Sea alone accounts for 1/50 of the whole amount. The brake on the Earth's rotation is thus a surface-brake; and the hypothesis suggests itself that there may be a slip of the outer crust over the interior at the "zone of weakness." If the slip is irregular, this would help to explain certain astronomical observations of irregularities in the longitudes of the moon, sun, and planets. It might even be the cause of the motion of the magnetic poles. The brake, being applied irregularly over the surface, would also tend to crumple the crust. The postulated looseness of the crust might also permit the North Pole to move about over the surface; but exceedingly long periods of time would be required, since there is no systematic tendency of the crust to move in latitude.

THE OPTICAL SOCIETY.

EXTRAORDINARY GENERAL MEETING.

An Extraordinary General Meeting of the Society, called by the President at the request of the Council, under Rule 21, was held at the Imperial College of Science and Technology, at 7.30 p.m., on Thursday, 14th December, 1922. The following addition to Rule 7 (Corporate Membership) was proposed and adopted:—

"At the request of a Fellow or Member of more than one year's standing, the Council may, by special resolution, transfer his membership to a specified Partnership Firm, Company, or other Corporate Body, with which he is associated. Such body may then be admitted to Corporate Membership in accordance with the preceding section of this Rule, but without the payment of an entrance fee, provided that the Fellow or Member then resigns in accordance with the conditions specified in Rule 10, and that if the subscription for Corporate Membership be greater than that paid for the current year by the Fellow or Member resigning, the difference be paid by the Corporate Member so admitted."

ORDINARY MEETING.

Immediately after the Extraordinary General Meeting, an Ordinary Meeting of the Society was held, when the following papers were presented and discussed:—

A Large Aperture Lens not Corrected for Colour, by T. SMITH, M.A., F.INST.P.

The Optical Cosine Law, by T. SMITH, M.A., F.INST.P.

Demonstrations were given of:—

The Measurement of the Internal Diameters of Transparent Tubes, and *A Simple Differential Refractometer for Liquids*, by Dr. J. S. Anderson, M.A., F.Inst.P.

There was also an exhibit and description of a *Constant Bubble* (unaffected in length by changes of temperature), by Messrs. E. R. Watts & Son, Ltd.

INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

The annual dinner of the Liverpool Section was held at the Liverpool Adelphi Hotel on Saturday night, Dr. F. J. Brislee (Chairman of the Liverpool and North-Western Counties' Association of the Institute of Chemistry) presiding over a large gathering of ladies and gentlemen, who spent an enjoyable time.

The principal guests included the Lady Mayoress, Sir Max Muspratt, Dr. and Mrs. E. F. Armstrong, Ald. and Mrs. Muirhead, the Hon. and Mrs. W. Hulme Lever, Mr. and Mrs. W. Moon, Dr. J. P. Longstaff (General Secretary of the Society of the Chemical Industry), Mr. H. Ballantyne (Vice-President of the Institute of Chemistry), Mr. R. B. Pilcher (Registrar of the Institute of Chemistry), and Dr. G. C. Clayton, M.P., and Mrs. Clayton.

The Chairman expressed his pleasure that the ladies had come to such a gathering, for they had a sphere of work wholly different from the men, and could do work with their delicate touch which could not be done by the coarser methods of mankind. He proposed the toast of "Our Guests," and the response was made by Dr. Armstrong, F.R.S., *President of the Society of* Chemical Industry.

Dr. Armstrong declared that his position was most difficult, and he felt that he would like to repeat an expression he heard in the States and then sit down, and the expression was, "We are glad to have you know us." (Laughter.) Now that Dr. Clayton had got into Parliament, they hoped that the lot of chemists would be materially improved. (Applause.) They might talk a great deal about the influence of chemistry on women, but he would ask, "Where would chemistry be without women?" The British dyestuffs would not even try to exist. (Laughter.) They would *not have all those troubles about Protection and Free Trade about the British dyestuffs.* (Laughter.) Then, again, what would be the use of aspirins if there were no women in the world? (Laughter.) Many societies appealed to chemists and people engaged in the chemistry profession, but the two societies which had made the most progress during the last five years were the Institute of Chemistry and the Society of Chemcial Industry. (Applause.) He hoped they would come together in the future, because he felt if they spoke with one voice, and the ladies spoke with them and for them, they would be able to attain to the position they desired. (Applause.)

The Chairman, replying to the toast of his health, said it was during the war that chemistry was really discovered and found to be of national importance. They must not let the lesson be forgotten. Speaking of the great principles of the two societies with which they were connected, he said their sign manual was "professional efficiency." With such a combination, he thought the progress of chemistry in this country was assured. In the future chemistry would play a far greater part in the economics of everyday life than in the past. One had only to look at the appalling waste *of production through inefficient methods of manufacture—fuel need only be mentioned in that connection—to become convinced that a large amount of expert investigation was necessary to carry them on to* the golden age they hoped to reach in the future. (Applause.)

An enjoyable musical evening was spent by the guests, some of whom accepted the invitation of the hotel management to join the dancers in the magnificent ballroom.

GENERAL NOTES.

ENCOURAGING THE USE OF ELECTRICITY.

To stimulate interest in certain urgen electrical problems, *The Electrician* is a ranging a series of competitions, and is a locating £250 in prize money. These com petitions will be open to all persons wit out distinction of age, sex, or nationalit and will be held at quarterly intervals du ing 1923. The first will be for designs f the cheapest and best electrical instal tion for an "all-electric" house. T

second will call for a solution of the problem of how hot water can best be obtained electrically. The third will require a scheme to be prepared for the lighting of a village hall electrically. It is anticipated that not only will some interesting solutions be sent in, but that the results will stimulate electrical progress and lead to the cheaper and more efficient use of electricity. Full particulars of competitions are being published in *The Electrician*.

NOTICES OF BOOKS.

Synthetic Colouring Matters — Dyestuffs derived from Pyridine, Quinoline, Acridine and Xanthene, by J. T. HEWITT, M.A., D.Sc., PH.D., F.R.S. Pp. XI. + 405. London: Longmans, Green & Co., 39, Paternoster Row, E.C. 1922. Price 14s.

In the first two chapters of this monograph (one of those on Industrial Chemistry under the editorship of Sir Edward Thorpe), Prof. Hewitt deals with pyridine and quinoline and their homologues, and has made reference to the recent and most convenient methods adopted for the preparation of these bases and their derivatives.

It is interesting to note that certain of these have attracted attention recently since they are used to make dyes employed in sensitising photographic plates.

The chemistry of the cyanines and isocyanines is carefully described, and the application of the numerous products and derivatives receives adequate and authoritative treatment.

An account of the pyrone ring and oxonium salts is given, and this is followed by chapters on fluorone and fluorim compounds, and the pyronines and rosanines.

The number of synthetic dyes continues to increase almost to the point of confusion, so that few but specialists in this particular branch of organic chemistry can hope to keep in touch with the latest developments except by the perusal of such a book as this.

In his preface, Prof. Hewitt states that much information has necessarily been obtained from the patent literature, and it is hardly requisite to point out that a specification does not always contain the whole truth and nothing else.

Great care has evidently been taken to secure the latest information concerning these bases and the dyes to be obtained from them. The indexes and references [illegible] technologists, and others will find this monograph a very reliable guide and source of information concerning these synthetic colouring matters. J.G.F.D.

Annual Tables of Constants and Numerical Data — Chemical, Physical and Technological; (Tables Annuelles de constantes et données numériques de Chimie, de Physique et de Technologie). Vol. IV., Part I., Pp. XXXII. + 626. Part II., Pp. XXV., and 627—1377. Publisher for the British Empire: Cambridge University Press, Fetter Lane, London, E.C.4. 1922. Price £7.

The publication of these Annual Tables of Constants, which was discontinued during the war, is being resumed; the Committee responsible has now published Volume IV., in which are collected numerical data gathered from the scientific and technical papers, 1913-1916 inclusively.

The work, which is one of great magnitude, is now under the high authority of the "International Union of Pure and Applied Chemistry," and of the "International Research Council."

In its task, the Committee had to overcome great difficulties. In view of supporting the Committee, the "Union of Pure and Applied Chemistry" decided to form an "International Fund." Both France and the United States gave their adhesion in June, 1922; their subscription amounts to half the necessary sum. It is greatly to be hoped that the various countries in which an effective scientific and technical development has been reached will join without delay: their agreement would enable the Committee to publish Volume V., the matter for which is ready at hand. This book is to contain numerical data collected from 1917 to 1922 inclusively.

The importance of such numerical data is rendered clearly manifest day by day. Besides the names of practically all the scientific establishments of the world, the lists of subscribers contain those of a considerable number of firms dealing with the most varied branches of industry: Chemistry, Metallurgy, Electricity, Electro-Chemistry, Mechanics, etc., who are aware of the technical improvements to be derived therefrom, and of the financial changes brought in its train.

They are also aware that such information cannot be gathered by the ordinary bibliographic method, but only by carefully studying every separate scientific and technical periodical page by page.

Year-Book of Pharmacy and Transactions of the British Pharmaceutical Conference, Nottingham, 1922. J. & A. Churchill, 7, Great Marlborough Street. 1922.

The above year book, just issued, gives a fund of information valuable both to the pharmaceutical and the analytical chemist. The notes arranged alphabetically contain all the advances that have appeared in Birtish and foreign journals throughout the year, the section devoted to inorganic chemistry embraces many items of value that have appeared in publications not generally accessible to the student in chemistry. Among the "notes and formulæ" an abstract is given of a paper that appeared in the *Analyst*, on the use of Ultra-Violet Light in Analysis. The value of these rays in analysis is very considerable, and now that it is easy to obtain a beam of U.V. rays by anyone who has a half-watt lamp is available. The method of investigation is likely to be largely used.

The latter half of the book gives a full report of the British Pharmaceutical Conference, held in July last, at University College, Nottingham. The Presidential address by Professor H. G. Greenish, whose portrait appears on the front page, is exceedingly interesting reading.

The book contains the usual authors' and subject index, giving very full references.

BOOKS RECEIVED.

The Mysteries of Hypnosis, by GEORGES DE DUBOE. Pp. IX. + 235. 1922. Messrs. William Rider & Son, Ltd., 8, Paternoster Row, E.C.4. 5s. net.

Joannes Baptista van Helmont, Alchemist, Physician and Philosopher, by H. STANLEY REDGROVE and I. M. F. REDGROVE. Pp. 86. 1922. Messrs. William Rider & Son, Ltd., 8-11, Paternoster Row, E.C.4. 2s. net.

Oxidations and Reductions in the Animal Body, by H. D. DAKIN, D.Sc., F.I.C., F.R.S. Second Edition. 1922. Pp. VI. + 176. Messrs. Longman, Green & Co., 39, Paternoster Row, E.C.4. 6s. net.

Tables Annuelles de Constantes et Données Numériques de Chimie de Physique et de Technologie; Annual Tables of Constants and Numerical Data, Chemical, Pyhsical and Technological. Pp. 1,377. Vol. IV., two Parts. 1921 and 1922 (years 1913, 1914, 1915, 1916). Gauthrie Villars et Cie, Paris. Cambridge University Press, Cambridge. £7.

Discoveries and Inventions of the Twentieth Century, by EDWARD CRESSY. Pp. XXIII. + 453. Second Edition. 1922. Messrs. George Routledge & Sons, Ltd., Broadway House, 68-74, Carter Lane, E.C.4. 12s. 6d. net.

Flavouring Material, Natural and Synthetic, by A. CLARKE, F.C.S. Pp. XX. + 166. 1922. Messrs. Henry Frowde and Hodder & Stroughton, The Lancet Building, 1, Bedford Street, Strand, W.C.2. 8s. 6d. net.

A Dictionary of Applied Chemistry, by SIR EDWARD THORPE, C.B., LL.D., F.R.S. Pp. VIII. + 740. Vol. IV. 1922. Messrs. Longmans, Green & Co., 39, Paternoster Row, E.C.4. 60s. net.

Chemical Engineering Catalog, by COMMITTEE OF 'THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.' Pp. 1,187. Seventh Annual Edition. 1922. The Chemical Catalog Co. Inc., 19, East 24th Street, New York. 10 Dollars.

New Patents.

THIS list is specially compiled for the *Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

31329—Bewsher, J. N.—*Valves for acids, etc.* Nov. 16.

31596—Gas Light & Coke Co.—Conduct of chemical reactions involving use of gases, etc., under pressure. Nov. 18.

31597—Gas Light & Coke Co.—Crystallization. Nov. 18.

Abstract Published this Week.

Dyes' Intermediate Products. — Patent No 186517.—*Some important improvements in the* manufacture of dyes and in their intermediate products have been Patented by Messrs. British Dyestuffs Corporation, Ltd., Imperial House Kingsway, London.

Triarylmethane dyes containing a thiazole rin are prepared by condensing tetramethyldiamine benzhydrol or equivalent tetraalkyldiaminobenz hydrol (in which one or two alkyl groups may b replaced by benzyl groups) with an arylbenzthia zole and oxidizing the resulting leuco compoun According to examples, tetramethyldiaminoben hydrol is condensed with 1-phenyl-5-methylben thiazole, 4 -methoxy-1-phenyl-5-methylbenzthi zole, or dehydrothiotoluidine, and the leuco bas oxidized; the leuco base from dehydrothiotolu dine may be acetylated, or, according to the Pr visional Specification, it may be alkylated tretaed with phosgene. The products dye w or tannin-mordanted cotton and also unmordant cotton or paper, bright green shades.

1-Phenyl-5-methylbenzthiazole is prepared heating benzyl-*p*-toluidine with sulphur.

4 -*Methoxyl-1-phenyl-5-methylbenzthiazole* prepared by methylating 4 -oxy-1-phenyl-5-meth benzthiazole with methyltoluene sulphonate.

Messrs. Rayner & Co. will obtain printed co of the published Specifications, and forward post free for the official price of 1s. each.

THE CHEMICAL NEWS,

VOL. CXXV., No. 3721.

ROYAL INSTITUTION OF GREAT BRITAIN.

JUVENILE CHRISTMAS LECTURES.

Three O'clock Afternoon.

Six Steps up the Ladder to the Stars, by HERBERT HALL TURNER, D.Sc., D.C.L., F.R.S., Savilian Prof. of Astronomy, Oxford.

NINETY-SEVENTH COURSE ADAPTED TO A JUVENILE AUDITORY (ILLUSTRATED).

(I) *The Distance of the Stars*; (II) *The Discovery of the Planet Neptune*; (III) *Photographing the Stars*; (IV) *The Spectroscope and its Revelations*; (V) *Two great Streams of Stars*; (VI) *The Size of a Star.*

(I) Thursday, Dec. 28; (II) Saturday, Dec. 30; (III) Tuesday, Jan. 2; (IV) Thursday, Jan. 4; (V) Saturday, Jan. 6; (VI) Tuesday, Jan. 9.

The members of the Royal Institution have the sole right of obtaining tickets for the Christmas Lectures until December 18. There may be a limited number of tickets available for the use of non-members after December 20.

Juveniles between ten and sixteen years of age, half-a-guinea; adults, two guineas.

LECTURES BEFORE EASTER, 1923.

Friday Evening Discourses Addressed to Members and their Friends, at 9.0 p.m.

January 19: SIR JAMES DEWAR, LL.D., F.R.S., M.R.I., Fullerian Prof. of Chemistry, *Soap Films as Detectors; Stream Lines; Vortex Motion; and Sound.*

January 26: SIR ALMROTH WRIGHT, K.B.E., C.B., M.D., Sc.D., F.R.S., M.R.I., *The Machinery of Anti-Bacterial Defence.*

February 2: CHARLES F. CROSS, B.Sc., F.R.S., M.R.I., *Fact and Phantasy in Industrial Science.*

February 9: SIR JOHN RUSSELL, O.B.E., D.Sc., F.R.S. (Director of the Rothamsted Experimental Station), *"Rothamsted" and Agricultural Science.*

February 16: A. V. HILL, O.B.E., Sc.D., F.R.S. (Prof. of Physiology, University of Manchester), *Muscular Exercise.*

February 23: A. S. EDDINGTON, F.R.S., PRES.R.A.S. (Plumian Prof. of Astronomy, University of Cambridge), *The Interior of a Star.*

March 2: GEORGE C. SIMPSON, C.B.E., D.Sc., F.R.S. (Director, Meteorological Office), *The Water in the Atmosphere.*

March 16: MONTAGU R. JAMES, LITT.D., F.S.A., F.B.A. (Provost of Eton), *The Novels and Stories of J. Sheridan Le Fanu.*

March 23: SIR ERNEST RUTHERFORD, LL.D., D.Sc., F.R.S., M.R.I. (Prof. of Natural Philosophy; and Cavendish Prof. of Experimental Physics, University of Cambridge), *Life History of an Alpha Particle from Radium.*

GENERAL COURSES OF LECTURES BEFORE EASTER, 1923.

Three O'clock Afternoon.

Tuesdays, January 16 and 23: *Semi-Permeable Membranes and Colloid Chemistry.*—1: *The Theory of Ionic Equilibria and Semi-Permeable Membranes*: 2: *Relation to Problems of Colloid Chemistry and Biology*, by F. G. DONNAN, C.B.E., D.Sc., F.R.S., M.R.I. (Prof. of Inorganic and Physical Chemistry, University of London).

Tuesdays, January 30, February 6: *The Character and Cause of Earthquakes*, by R. D. OLDHAM, F.R.S.

Tuesday, February 13, Wednesday, February 21: *Greek Civilisation and To-day.*—1: *The Beginnings of Science*; 2: *Progress in the Arts*; by A. C. PEARSON, LITT.D. (Regius Prof. of Greek, University of Cambridge).

Tuesdays, February 27, March 6: *Life and Its Rhythms.*—1: *Life and Its Attributes*; 2: *Rhythm in Living Organism*: by SIR ARTHUR E. SHIPLEY, G.B.E., Sc.D., F.R.S. (Master of Christ's College, Cambridge).

Tuesdays, March 13, 20: *Rainmakers and Divine Kings of the Nile Valley*, by CHARLES G. SELIGMAN, M.D., F.R.S. (Prof. of Ethnology, University of London).

Thursdays, January 18, 25: 1: *The British Soldier and Regimental Officer at the close of the Napoleonic Wars*; 2: *The Campaigns of the British Army*, 1815-38; by THE HON. JOHN W. FORTESCUE, C.V.O., LL.D. (Librarian at Windsor Castle).

Thursdays, February 1, 8: *The Photosynthesis of Plant Products*, by I. M. HEILBRON, D.S.O., D.Sc., PH.D., F.I.C. (Heath-Harrison Prof. of Organic Chemistry, University of Liverpool).

Thursdays, February 15, 22: *Recent Experiments in Aerial Surveying*, by B. MELVILL JONES, M.A. (Francis Mond Prof. of

Aeronautical Engineering, University of Cambridge).

Thursdays, March 1, 8: *Water Power of the Empire*, by THEODORE STEVENS, B.MET., MIN.ENG., M.INST.C.E., M.I.E.E.

Thursdays, March 15, 22: *Japanese and Chinese Lacquer*, by LIEUT.-COL. E. F. STRANGE.

Saturdays, January 20, 27: *Speech Rhythm in Vocal Music*, by SIR WALFORD DAVIES, MUS.DOC., LL.D. (Director of Music in the University of Wales), with illustrations by members of the Temple Choir.

Saturdays, February 3, 10: Subject in Poetry (with special reference to contemporary practice), by J. C. SQUIRE, M.A. (Cambridge), Editor *London Mercury*.

Saturdays, February 17, 24, March 3, 10, 17, 24: *Atomic Projectiles and Their Properties*, by SIR ERNEST RUTHERFORD, LL.D., D.Sc., F.R.S., M.R.I. (Prof. of Natural Philosophy, and Cavendish Prof. of Experimental Physics, University of Cambridge).

ACTION OF AMMONIUM NITRATE AND AQUEOUS AMMONIA ON COPPER.

BY *H.* BASSETT AND *R. G.* DURRANT.

The authors remark that ammonium nitrate effects a corrosive action on copper, and such is important in the manufacture of munitions. Explosives containing ammonium nitrate are liable to cause corrosion of shell cases in the presence of moisture. Atmospheric oxygen seems essential in the reaction. The products of corrosion consist of cupric tetrammine nitrate $Cu(NH_3)_4(NO_3)_2$, which is in the form of dark blue prismatic crystals, and also basic copper nitrate $Cu(NO_3)_2.3Cu(OH)_2$. The sum total of the reaction may be approximately represented by the equation:

$$5Cu + 4NH_4NO_3 + H_2O + 5O = Cu(NH_3)_4(NO_3)_2 + Cu(NO_3)_2.3Cu(OH)_2.$$

In actual corrosion, the two copper compounds are not found in equimolecular quantities, owing to secondary reactions such as the hydrolysis of the tetrammine, etc.

By immersing copper gauze in saturated ammonium nitrate, the basic nitrate is quickly formed, while if the gauze projects above the surface of solution, the tetrammine will also be produced. This latter substance melts at 210° C., and explodes at 212°, leaving cupric oxide as a residue. It slowly hydrolyses in moist air to the basic nitrate.

The formation of nitrate when copper is left in a solution of ammonia, results from the oxidation of the ammonia. The authors have shown that when finely divided copper is allowed to react with ammonia in the presence of air, the formation of cupric tetrammine nitrite occurs (cf *Peligot, Compt. rend.*, 1861, LIII., 209), and several methods are described for preparing this compound.

When this substance is carefully heated for 24 hours at 97° C., cupric diammine nitrite $Cu(NH_3)_2(NO_2)_2$ is formed, while if exposed to moist air, it gives up half its ammonia with the formation of the diammine nitrite, and finally by hydrolysis there is formed the basic nitrite.—(*Trans. Chem. Soc.*, 1922, p. 2630.)

RESEARCH WORK AT BIRMINGHAM UNIVERSITY.

An interesting account of important research work which has recently been carried out at the Chemical Department of the University of Birmingham by Professor G. T. Morgan, F.R.S., and student collaborators, was given on Tuesday night, December 5, at that University, at a special meeting of the Society of Chemical Industry, in conjunction with the Chemical Society. There was a representative attendance, and Dr. Edward B. Maxted presided.

Paper I.:

Researches on Residual Affinity and Co-ordination, by PROF. GILBERT T. MORGAN and MR. HARRY GORDON REEVES, M.Sc.

This was Part XV. of the researches, and dealt with interactions of acetyl-propionyl-methane and the tetrachlorides of selenium and tellurium.

Acetylacetone has the noteworthy property of forming derivatives with the majority of chemical elements. In some cases these derivatives have remarkable characteristics, for instance, the acetylacetones of aluminium, beryllium, chromium, manganese, and scandium can be distilled without decomposition. In the words of the late Sir William Crookes, this reagent "has given wings to the metals."

Acetyl-propionyl-methane (propionylacetone), preferably in the form of its copper derivative, behaves towards selenium tetra-

chloride in its ordinary monoenolic modification, $C_2H_5.C(OCh\ ):CH.CO.CH_3$, and yields selenium acetyl-propionyl-methane, $Se_2(C_6H_8O_2)_2$.

With tellurium tetrachloride, acetyl-propionyl-methane reacts in its methylene enolic form,

$$C_2H_5.CO.CH_2.C(OH):CH_2,$$

giving rise to tellurium acetyl-propionyl-methane-di-chloride $(C_6H_8O_2)TeCl_2$. On reduction this dichloride furnishes tellurium acetyl propionyl-methane, $Te(C_6H_8O_2)$, a substance having an intense bactericidal action.

Paper II.:

The Upper Limit of Diazotisability in the Benzene Series (Diazo-derivatives of Mesitylene), by PROFESSOR MORGAN and MR. GLYN REES DAVIES, M.Sc.

Professor Morgan observed that the subject had a Midland interest, in that the diazo-reaction, which was the most important general reaction in the chemistry of coal tar products, was first investigated by Peter Griess, about 60 years ago, in the chemical laboratories of Messrs. Allsopp & Co., of Burton-on-Trent. Griess studied the diazotisation of monoamines and diamines of the aromatic series, and laid the foundation of the manufacture of azo-dyes, but hitherto no one had examined the behaviour of a simple aromatic triamine towards nitrous acid.

When treated with three molecular proportions of nitrous acid, tri-amino-mesitylene hydrochloride in acid solution is diazotised only in two of its amino groups, yielding amino-mesitylene-bis-diazonium-chloride identified by conversion into amino-mesitylene-bis-azoimide, $NH_2.C_9H_9N_6$, and the aurichloride hydrochloride, $HCl, NH_2.C_9H_9(N_2.AuCl_4)_2$.

When, however, this diazotisation with excess of nitrite is effected in presence of hydrazoic acid, the formation of the foregoing bistriazo compound is followed immediately by the diazotisation of the third amino group, thus leading to the production of tris-triazo mesitylene, $C_9H_9N_9$.

It is inferred from these results that in a monocyclic triamine of the benzene series, only two or the three amino groups can be diazotised concurrently. The diazotisability of the third amino group is manifested only after the two first formed diazonium complexe shave been substituted by other groups such as the triazo radicle.

Paper III.:

Studies in the Normal Butyl Series.—Part II.: The 4 Stereoisomeric βγ di-p-tolyl-amino-N-butanes, by PROFESSOR MORGAN and MR. W. J. HICKINBOTTOM, M.Sc.

Professor Morgan pointed out that stereochemistry was first systematically studied by Louis Pasteur, 70 years ago, when he showed that at temperatures below 28° an aqueous solution of sodium ammonium racemate furnished crystals of two optically active sodium ammonium tartrates. Each of these salts possessed the property of rotating the plane of polarised light, but in one case the rotation was to the right, whereas in the other it was to an equal degree towards the left. Pasteur also discovered a fourth modification of tartaric acid, mesotartaric acid, which could not be resolved into optically active components. When βγ-dichloro-n-butane or the corresponding dibromo-compound is condensed with p-toluidine- two isomeric diamines are produced having the same graphic formula,

$$p.\ C_7H_7NH.\ CH(CH_3).CH(CH_3)NH.\ C_7H_7.p.$$

The less fusible isomeride, is a racemoid substance resolvable by the aid of d-γ-bromocamphor-R sulphonic acid, into two optically active enantiomorphs,

d- and *l*-βγ-di-p-tolyl-amine-n-butane.

The more fusible isomeride, which is non-resolvable, is meso-βγ-di-p.tolylamine-n-butane.

These four stereoisomeric modifications of the same diamine furnish a complete analogy with the four stereoisomeric tartaric acids, this being the first instance in which a complete set of four basic substances containing two asymmetric carbon atoms has been isolated in definitely crystalline forms.

Duirng the condensation between p.toluidine and the di-halogenated n-butanes a basic by-product is isolated, yielding characteristic bright yellow salts; this base has been identified as 3:5:7 tri-methyl acridine.

Reference was made by the Chairman to the active and productive work which is being done at the Chemical Department of the Birmingham University.

(1) Sulphur dioxide may be absorbed by cattle cakes and meals during fumigation, but that after about a week the sulphur dioxide disappears.

(2) The amount of sulphur dioxide absorbed seems to depend on the variety of cake, the harder cakes absorbing less than the softer, and the condition of the feeding stuff, *i.e.*, whether in block or powder form.

(3) Any deleterious effect, commonly ascribed to the consumption of sulphured feeding stuffs by farm stock, cannot, therefore, under practical feeding conditions, be due to the presence of sulphur dioxide.

Abstract.

A Sliding Scale for the Convenient Titration of Strong Liquids by Dilution and Use with Aliquot Parts, by C. H. Douglas Clark, B.Sc., D.I.C., A.I.C.

The device described by the author is a sliding scale designed to assist chemists who are frequently titrating strong solutions against weaker standards by dilution and measurement of a known volume. The scale is easily made, and can be set in different positions, depending on the dilution. It enables the operator to see at once what alternative dilutions are available in any particular case, in order that a convenient burette reading may be obtained at the end of the process, and is designed to assist him in his choice of the most suitable dilution for the purpose required without unnecessary thought or delay.

Abstract.

Some Notes on the Unsaponifiable Matter of Fats, by D. W. Steuart, B.Sc.

In the case of margarines which contain no coconut, palmkernel, or butter fat, it is rather difficult for the analyst to satisfy himself whether he is dealing with a real animal fat margarine, or whether the margarine contains palm oil or hardened vegetable oil. The percentage of sterol in the unsaponifiable matter and the melting point of the sterol acetate have been examined, but these do not yield the information desired. The recognition of polymerised oils and the detection of lecithin are briefly referred to. The proportion of sterol in the unsaponifiable matter varies from 48 per cent. in maize oil to 7 per cent. in palm oil; and from 38 per cent. in lard to 9 per cent. in hardened whale oil. Highly hardened fats still contain sterol. The cholesterol acetate of animal fats melts at 114 to 114½° C., the phytosterol acetate of vegetable fats is a mixture, a fraction of which melts at 125° C. or above, but some pure vegetable oils yield a fraction melting about 114° C.

Abstract.

Note on the Sulphuric Acid Test for Fish Liver Oils, by Norman Evers, B.Sc., F.I.C., and H. J. Foster.

The addition of natural vegetable or animal oils, such as olive, arachis, lard oils, or tallow, which do not themselves give any colour with sulphuric acid, increases the sensitiveness of the test to a remarkable extent. Oxidation of the oils destroys this power but it is unaffected by hydrogenation. The active substance is not cholesterol or phytosterol. It is not present in commercial oleic acid, stearic acid, mono- or di-glycerides. The brown colour produced by sulphuric acid with liver oils after oxidation, is shown to behave in exactly the same manner as the violet colour with the fresh oils, being similarly increased by the addition of natural oils.

THE CHEMICAL SOCIETY.

The Library of the Chemical Society will be closed for the Christmas holidays at 1 p.m. on Friday, December 22nd, and will reopen at 10 a.m. on Thursday, December 28th.

SOCIETY OF GLASS TECHNOLOGY.

A meeting of the Society was held in the Physical Chemistry Theatre, University College, Gower Street, London, W.C.1, on Wednesday, December 13th, 1922, at 2.30 p.m.

Agenda:

Minutes of meeting held on November 22nd, 1912.

Applications for membership.

A paper entitled *Improvements in the Deisgn of Recuperative Glass Pot Furnaces* was read by T. Teisen, B.Sc.

General discussion on *The Use of the Autoclave in Testing Glass.* The subject was introduced by the following papers:—

(a) *Some Aspects of the Autoclave Test*, by W. L. Baillie.

(b) *Some Criticisms on the Use of the Autoclave as a Method for Testing Glassware*, by W. H. WITHEY, B.A.

(c) *Some Difficulties in the Interpretation of Autoclave Results*, by PROF. W. E. S. TURNER, D.Sc., and F. W. HODKIN, B.Sc.

By the courtesy of the University College Authorities, tea was available for members, at the usual charges, in the College Refectory after the meeting.

WORKS EXCURSION.

By the courtesy of the directors, a visit was made to the new Glass Works of Messrs. General Electric Co., Ltd., North Wembley, on Thursday morning, December 14th, 1922.

The plant is engaged in the manufacture of glass tubing. It includes a twelve-pot *Hermansen recuperative furnace* (each pot having a capacity of 2,500 pounds), two Danner tube making machines, and subsidiary reheating furnaces.

SIR WILLIAM CROOKES'S ANTI-GLARE GLASSES.

BY J. H. GARDNER, F.INST.P.

Read at a Meeting of the Optical Society, held at the Imperial Institute of Science and Technology, South Kensington.

Mr. President and Gentlemen,—When a few days ago I was asked on the telephone by your Secretary, Mr. Sutcliffe, to say a few words to-night about Sir William Crookes's Anti-Glare Glasses, I found myself unable to refuse, firstly because the request was made in such a "persuading" way that I had not the heart to say "No," and secondly because I suppose that I have the privilege of knowing as much as anyone about the subject, having been intimately associated with the late Sir William Crookes for more years than I care to count, working under him in all the researches connected with the glasses that bear his name.

Sir William was deeply interested in the subject, and was engaged upon the work at the time of his death.

I have a photograph of Sir William, taken at the time when Anti-Glare Glasses formed the chief topic of discussion at the laboratory.

A few words briefly giving the history of the research may not be out of place.

The work on the radiation transmission of transparent substances began with an enquiry into the cause of Glass-makers' Cataract, and several years of hard work were devoted to it, and in 1914 a paper was read before the Royal Society in which formulæ were given for many glasses having special optical properties, and manufacturers were encouraged to produce them for general use.

As a result, Sir William was inundated with enquiries from private people needing assistance for eyesight trouble, and from manufacturers of glass wishing to use his name for glasses that they had succeeded in making from his published formulæ.

It soon became evident that further work was necessary to produce a glass that would absorb as much Ultra-violet radiation as possible, and at the same time transmit the bulk of the visible rays; the glass also had to be pleasing in appearance.

It was evident that it would be necessary to make a variety of tints to suit different climatic conditions.

The work was carried out with the assistance of Mr. Harry Powell, of Whitefriars Glass Works, whose death unhappily occurred a few days ago.

Agreements were made between Sir William and Mr. Nelson Wingate, of Wigmore Street, W., for the glasses to be placed upon the market as soon as conditions made their production possible.

Some of these glasses are on exhibition here to-night.

Many causes that I need not enter upon now have prevented very large production, but it is hoped that the output will be increased shortly; the glass is of a very special character, and presents unexpected technical difficulties.

On the death of Sir William, the whole of the data for the preparation of the glasses and the apparatus that had been devised for obtaining measurements of the radiation transmitted and absorbed by them were given into my charge, and will shortly be erected at the laboratories of the new Whitefriars Glass Works at Wealdstone, where we hope to be able to produce the material in larger quantities than has been possible at the old works in London.

ON THE PREPARATION OF COLLOIDAL SOLUTIONS OF NICKEL AND COBALT HYDROXIDES AND SOME OTHER COMPOUNDS OF THESE METALS.*

By O. F. Tower and Martha C. Cooke.

Some years ago one of us, while investigating the tartrates of nickel and cobalt,[1] encountered a number of solutions of these substances which were evidently of a colloidal nature. In this paper the results of further investigations of these same substances are described together with some new methods for preparing colloidal solutions of the hydroxides of nickel and cobalt. The former paper should be consulted for a description of the nature and properties of the simple tartrates of these metals and of their double tartrates with potassium. The methods of analysis employed in this work are the same as those there set forth. Dialyzing was carried out either in parchment or collodion bags, which insures rapid diffusion. These were hung in distilled water, which was frequently changed. Parchment seemed to work the best, as the collodion apparently allowed larger particles to pass through, especially in the strongly alkaline solutions.

Simple nickel and cobalt tartrates, when prepared by dissolving the freshly precipitated hydroxides in tartaric acid are not colloids. These solutions are in a state of supersaturation and on standing deposit the crystalline salts. When, however, to these solutions sodium or potassium hydroxide is added a colloidal solution results, and in case solutions as concentrated as "normal" are employed the nickel solution forms a transparent gel. If fifth-normal solutions are used no gel is obtained. The solution is, however, colloidal, as examination by means of the ultramicroscope shows. The gel obtained with the more concentrated solutions after standing several days deposits a light green precipitate of nickel tartrate mixed with variable amounts of potassium tartrate. Whatever may be the nature of the substance in solution,[2] the precipitate in every case is simply nickel tartrate with more or less potassium tartrate adsorbed in it. The dilute solutions which did not gel were subjected to dialysis. In most cases all of the potassium and tartrate radical passed through the membrane leaving colloidal nickel hydroxide inside. Solutions containing at the most 3.2 grams of nickel hydroxide per litre were prepared in this way. The results just described were best obtained when tartaric acid and potassium hydroxide were in molecular proportions, that is, one molecule of the acid (not as free acid, but as nickel tartrate) to one molecule of the hydroxide. If the quantity of hydroxide exceeded this to any great extent, either all of the nickel would diffuse through the membrane also, or some nickel tartrate would precipitate inside the parchment bag as the potassium tartrate diffused out.

Similar solutions containing cobalt acted quite differently; for one reason because cobalt has a tendency to become oxidised to the cobaltic condition in a strongly alkaline solution. If the amount of potassium hydroxide employed was the least possible required to hold cobalt hydroxide in solution,[1] no oxidation seemed to take place. When such a solution was dialyzed one of two results occurred: either light pink cobalt tartrate was precipitated after a day or two inside the bag, or no precipitation at all took place, and after dialyzing several days the contents of the bag consisted of a currant-red gel. Analysis of this gel showed it to be for the most part cobalt tartrate with small quantities of potassium tartrate adsorbed in it. Prolonged shaking of this gel with distilled water failer to peptize it.

In case a greater excess of potassium hydroxide was used in forming these solutions, oxidation would begin at once and the colour would change from pink to purple, to green, and after many days to brown. If solutions as concentrated as "normal" were used, the solutions would set ot a gel in about 24 hours (not at once as in the case of the nickel solutions), or about the time the colour began to change. This gel lasted about two weeks, or about the time the colour change was completed, when it gradually passed over into an ordinary solution containing a slimy brown precipitate. More dilute solutions passed through the same changes except that no gel was formed. No attempt was made to dialyze any of the solutions in which co-

* *From Journal of Physical Chemistry, November, 1922, p. 718.*

[1] *Tower: Jour. Am. Chem. Soc.*, 1900, XXII., 501.

[2] See loc. cit., p. 510.

[1] *See loc. cit., p.* 517.

balt had obviously become oxidised, as methods of obtaining colloidal solutions of cobaltous hydroxide were being sought.

The literature, as far as we have been able to find, contains but one reference to the preparation of colloidal cobalt hydroxide without the employment of a protective colloid. A. Müller,[1] in 1908, peptized a number of freshly precipitated metallic hydroxides by means of hydrochloric acid or hydrolysed salts of the same metals. In the case of cobalt he used the freshly precipitated hydroxide and hydrochloric acid, and obtained a colloidal solution, which, however, began to deposit a precipitate within 24 hours. Nickel hydroxide is not mentioned.

In addition to the experiments, which have been described to try to obtain colloidal solutions of nickel and cobalt hydroxide by dialyzing solutions of their double tartrates and which resulted successfully only in the case of the former, other methods were also undertaken as follows. Nickel and cobalt hydroxides dissolve in excess of both ammonium hydroxide and carbonate, but as in these cases they form well defined double salts or complex molecules, it was scarcely expected that any colloidal solutions would be produced by subjecting them to dialysis; and such was found to be true. On dialyzing, either the whole of the substance in solution passed through the membrane, or sometimes only the ammoniacal portion, in which latter case the metallic hydroxide or carbonate, as the case might be, was precipitated inside the bag.

One of the best ways of preparing a colloidal solution of nickel hydroxide was discovered accidentally while preparing the hydroxide for conversion into the tartrate. For this purpose a solution of nickel chloride was treated with a little more than the equivalent quantity of a solution of potassium hydroxide, the precipitated nickel hydroxide allowed to settle, the supernatant liquid siphoned off, more water added, and the process repeated several times. It was found that the original concentration of the two solutions mixed was the principal factor in determining how rapidly the nickel hydroxide would settle. If normal solutions were mixed and then diluted afterwards, settling occurred fairly rapidly (say 20 minutes) and all traces of alkali can be washed out in three or four hours. If tenth-normal solutions are mixed, settling takes place much more slowly; and if hundredth-normal solutions are mixed, all day is required for the nickel hydroxide to settle sufficiently so that the supernatant liquid can be drawn off. For the purpose in hand solutions of a concentration about tenth-normal gave the best result. About 500 cc. of each solution were poured together in a tall beaker, thoroughly mixed and set aside to settle. This took about one hour the first time. After siphoning off the solution, about 900 cc. of distilled water was added and thoroughly mixed with the precipitate by pouring back and forth from one beaker to another. Settling took longer this time, and the time increased with each successive washing. After about six such washings during one day, the precipitate was allowed to stand over night with the same quantity of water to settle again, but in the morning the precipitate had vanished and a colloidal solution of nickel hydroxide remained. The solution was somewhat opalescent, exhibited the Tyndall effect, and showed distinct particles under the ultramicroscope.

On different trials the amount of nickel hydroxide thus going into solution varied considerably, for this depends so much on the nature of the precipitate formed when the two original solutions are mixed. If two dilute solutions are employed the precipitate first formed is so finely divided that it is almost impossible to wash it by this method, as it settles too slowly; and unless the potassium chloride is for the most part removed colloidal nickel hydroxide will not form, or at least the sol will not be sufficiently stable to last any length of time. To strike just the right conditions is a matter o fsome difficulty. In the most successful experiments one litre of solution contained about 1.5 grams of nickel hydroxide.

When such solutions were subjected to dialysis, nickel hydroxide would begin to precipitate within 24 hours, and traces of chloride ions would be found in the dialysate, although the original colloid solution gave a practically negative test for these ions. By estimating the quantity of chlor-

[1] *Zeit. anorg. Chem.*, LVII., 311.

ide ions removed by dialyzing,[1] it was calculated that the solutions contained an equivalent of about 1 cc. tenth-normal potassium chloride in one litre. This seems to show that in order to hold nickel hydroxide in colloidal solution there must be approximately 1 molecule of potassium chloride to 200 molecules of nickel hydroxide. Experiments showed that nickel hydroxide, like other metallic hydroxides, is a positive colloid and gradually drifts toward the negative pole under the influence of a sufficient potential difference. These experiments were carried out in U tubes using a potential difference of 110 volts. The nickel hydroxide is probably stabilised by the potassium ions adsorbed by it. It is well known that other similar colloids adsorb positive ions in this way; but, so far as we know, no colloid is so sensitive to a small change of concentration of these ions as is the nickel hydroxide prepared in the manne rjust described; for it is precipitated by a slight increase in the concentration of potassium chloride as well as by its removal. Aggregation of the particles in these solutions goes on slowly but continuously, for in the course of six or eight weeks all of the nickel hydroxide precipitates and the solutions become optically empty. The colloidal solutions of nickel hydroxide prepared by dialyzing the double tartrate are more stable, as most of them are perfectly transparent now after standing four months.

Cobalt hydroxide does not pass as readily into colloidal solution when prepared in this manne ras does nickel hydroxide, that is, by precipitating from dilute solutions and washing by repeated siphoning off of the supernatant liquid. However, very dilute solutions of a brownish colour can be obtained in this manner. They exhibit the Tyndall effect and show particles under the ultramicroscope, although their concentration in no case exceeded 0.05 gram of cobalt hydroxide per litre. They are also not very stable, for after standing a few days all of the hydroxide coagulates and precipitates.

Since tartaric acid holds nickel hydroxide in solution, one would expect that glycerine would act similarly. In fact, Chatterji and Dhar[1] state that this is the case, provided the glycerine is added to the solution of the metallic salt before adding sodium hydroxide. We have, however, been unable to confirm this for nickel salts, although we have found it to be true for cobalt salts and the others mentioned by these investigators. Four salts of nickel, the chloride, nitrate, sulphate and acetate, were tried in varyin gconcentrations and with varying quantities of glycerine with both sodium and potassium hydroxides, but with negative results. In a few cases precipitation of nickel hydroxide would be delayed for fou ror five minutes, but not longer. Nickel acetate dissolves directly in glycerine. If to such a solution an aqueous solution of sodium or potassium hydroxide was added, a precipitate resulted at once. If, however ,an alcoholic solution of potassium hydroxide was employed, no precipitation occurred, and in a few minutes the whole mixture set to a gel. These were the only conditions under which we found that glycerine would hold nickel hydroxide in solution. If this gel was diluted with water or with 90 per cent. alcohol, nickel hydroxide was thrown down immediately by the water and after a few minutes' delay by the alcohol. On standing, this gel underwent some interesting changes. After standing about 24 hours it clouded up and became opaque. It continued in this state for 10 or 12 days, after which syneresis began. The liquid portion rapidly increased in amount and in a few days entirely peptized the solid portion, so that a limpid green solution remained. Dilution with water now caused no precipitation, although the solution was distinctly alkaline. A portion of this dilute solution was then placed in a collodion tube and dialyzed. In three or four days the contents of the tube had gelled. The gel consisted of nickel hydroxide with some organic matter in it. The excess of alkali had dialyzed out. A second portion of the diluted solution standing without dialyzing for the same length of time did not gel. It of course still contained excess of potassium hydroxide.

[1] *This was accomplished by comparing the cloudiness obtained by adding tenth-normal silver nitrate to 500 cc. of the dialysate with that obtained from standards prepared by treating 500 cc. of solutions containing known amounts of potassium chloride with tenth-normal silver nitrate. This method could not be used with the original colloidal solution because of its greenish colour and slight opalescence.*

[1] *Trans. Faraday Society, Vol. 16, appendix to Part 3.*

It might be stated, in closing, that both colloidal nickel and cobalt hydroxides are reported to have been prepared by Paal's method,[1] that is, by employing certain protein decomposition products as protective colloids. Our experiments have, however, been limited to attempts to prepare such solutions without the aid of protective colloids.

It is well known that nickel sulphide is readily held in colloidal solution in the presence of a large excess of alkali, especially if an organic substance like tartaric acid or glycerine is present.[2] We have found that if such solutions are dialyzed the nickel sulphide is completely precipitated and the remianing liquid is optically empty. The tartrates, glycerine and excess of alkali pass through the dialyzing membrane, and their stabilising effect is evidently required to keep nickel sulphide in the colloidal state

The conclusions of this paper may be thus summarised:

1. Two methods are described for preparing colloidal soletions of nickel hydroxide, one by dialyzing a solution of nickel tartrate in the presence of an alkaline solution of potassium tartrate, and the other by a specia lmethod of precipitating and washing the hydroxide itself.

2. Cobalt(ous) hydroxide does not pass readily into colloidal solution by these methods; only very dilute solutions of it could be obtained.

3. The tartrates of nickel and cobalt in the presence of an excess of alkali exist in the colloidal state.

4. In a former paper evidence was presented for the existence in solution of such salts as,

```
COOK       KOOC              COOK
HCOH       HOCH     and      HCO
                                  >Ni
HCOH       HOCH              HCO
COONiONiOOC                  COOK
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but since we have here to deal with solutions of colloids that evidence is of little value. Any solids obtained from such solutions appear to be only nickel tartrate with more or less potassium tartrate adsorbed in it.

5. Glycerine does not prevent the precipitation of nickel hydroxide from aqueous solutions. In alcoholic solution interesting transformations occur, and a solution is eventually obtained from which nickel hydroxide cannot be precipitated by diluting with water.

6. Colloidal solutions of nickel sulphide, which are readily formed in the presence of an alkaline solution of a tartrate, immediately decompose with precipitation of the sulphide on dialyzing out the tartrate.

The Morley Chemical Laboratory,
Western Reserve University.
June, 1922.

[1] *German patent* (1906), *described in Svedberg's "Herstellung kolloider Lösungen,"* p. 327.

OBITUARY.

We regret to record the death of Mr. Harry Powell, O.B.E., on Sunday, the 26th of November. Mr. Powell was for 46 years manager of the Whitefriars Glass Works, which he joined in 1873, and from then until 1919, when he retired, his whole energies were devoted to the advancement of British glass craftsmanship. Under his direction glassware of the highest quality and unique design has been produced in the factory of Whitefriars. This factory was built on the site of the Carmelite Monastery, and has been used as a glasshouse for the last 250 years. Mr. Powell did more than anyone to maintain the high standard of British glassware, and many examples of his work are now in the South Kensington Museum. During the war he rendered important service by the production of glass tube that was used in large quantities for the projecting horns of marine mines.

Mr. Powell devoted a deal of his time to education, and had for many years been chairman of James Allen's Girls' School, East Dulwich; he was also a governor of Dulwich College.

We have received a copy of the Christmas number of *Work*. The issue, which consists of forty pages, is fully illustrated and gives details on many matters which are specially useful at this time of the year. Here are a few of the subjects which are typical of the contents as a whole: "Making Up for Amateur Theatricals"; "Making Christmas Cards at Home"; "Home Decorations and Illuminations"; "Some New Conjuring Tricks for Amateurs"; "Amateur Wireless at Home"; "Parlour Tricks for Christmas Parties"; "Easily-made Chinese Lanterns," and "Preparing for the Christmas Party: The Parlour Stage and its Arrangements."

A NEW METHOD FOR THE GRAVIMETRIC DETERMINATION OF GERMANIUM.*

[CONTRIBUTION FROM THE JOHN HARRISON LABORATORY OF CHEMISTRY OF THE UNIVERSITY OF PENNSYLVANIA.]

By John Hughes Müller.

Analytical procedure for the quantitative determination of germanium has not changed since the early investigations of Winkler[1] immediately following his discovery of the element in 1886; that is to say, germanium has always been weighed as sulphide or dioxide and no other compound has been reported which admits of direct applicatiou to quantitative estimation.

Weighing of the disulphide yields excellent results, but is usually avoided on account of the required washing for the remova lof free sulphur, as well as the inability of this salt to withstand ordinary ignition. In consequence, the sulphide is nearly always converted to dioxide by frequent evaporation with nitric acid and ignition to constant weight.

In many determinations it has been the writer's experience that the conversion of sulphide to oxide, aside from being time consuming, is subject to serious conflicting errors. First, the sulphide is violently attacked by even dil. nitric acid and yet must be thoroughly decomposed by this acid before much heat is applied to the residue. Second, after complete oxidation, the removal of all of the sulphuric acid is very difficult, if indeed possible.

A slight loss of germanium through volatility of the unoxidized sulphide plus the mechanical loss in the escaping oxides of nitrogen tends to give low results, but on the other hand the tightly held sulphuric acid which clings to the ignited residue causes error in the other direction. These conflicting or balancing errors are practically beyond control of the analyst, and have suggested to the writer the search for an altogether different method for the estimation of germanium.

The purpose of this communication is to describe a new method for the gravimetric determination of germanium, which is based upon the action of magnesia mixture upon solutions of germanic oxide in the presence of free ammonia.

[1] Winkler, J. prakt. Chem., 1886, [2] 177; 1887, XXXVI., 177.

It will be shown that, under proper conditions, the precipitate consists entirely of magnesium orthogermanate (Mg_2GeO_4), which hitherto unreported compound appears to possess all of the properties required for its use in this connection.

REAGENTS AND APPARATUS.

The following reagents were employed throughout this work. A normal solution of magnesium sulphate, free from silica, iron, calcium. A 2*N* solution of ammonium sulphate, free from heavy metals and alkaline earths; ignition of a 5g. sample gave an inappreciable non-volatile residue.

Ammonium hydroxide, sp. gr. 0.89; this was freshly prepared by distillation from platinum and was preserved in vessels of the same material.

Hydrogen peroxide, a 30 per cent. solution, free from phosphoric acid and other non-volatile matter.

Germanic acid in aqueous solutions of different concentrations. The stock solution from which the other more dilute solutions were prepared contained 0.004308 g. of GeO_2 per cc. at 26°. These solutions were restandardised separately by evaporation of 50 cc. samples and ignition of residual oxide to constant weight. The germanium dioxide was of the highest degree of purity and entirely free from arsenic.

Ordinary distilled water, freshly prepared, was used. The flasks and pipettes were calibrated at 26°; the balance was a Troemner No. 10, with a sensibility of 0.00002 g.; the weights were recalibrated. Porcelain crucibles and Pyrex glassware were used throughout. All precipitates were collected upon ashless filter paper upon which the operation of drying and ignition was performed without disturbing the mass of precipitate.

PRELIMINARY EXPERIMENTAL WORK.

One hundred cc. of an aqueous solution of germanic acid containing 0.4308 g. of germanium dioxide was treated with 25 cc. of *N* magnesium sulphate solution and 15 cc. of 2 *N* ammonium sulphate solution.

Upon addition of 20 cc. of conc. ammonium hydroxide, a bulky white precipitate immediately formed. 8he mixture was raised to boiling, allowed to cool and to stand for 12 hours. The filtrate and wash water were separately collected and examined for germanium as follows. Each was neutralised and then made approximately 6 *N* with sulphuric acid. The acid solutions were now saturated with hydrogen sulphide in the cold. Only a slight tur

bidity appeared in about an hour. In 24 hours each solution contained a small precipitate, which was converted to oxide in the usual way and weighed. The filtrate, measuring 140 cc., contained 0.0002 g. of germanium dioxide. The wash water, which was originally slightly ammoniacal, contained 0.0004 g. of germanium dioxide in 50 cc. This procedure was repeated several times and in no case was more than 0.0005 g. of germanium dioxide found in the combined filtrate and wash water.

Precipitation of the same quantity of germanium was carried out in the presence of a much larger excess of ammonium salt. The filtrate then contained an appreciable quantity of unprecipitated germanium, even after several days' standing. For example, 100 cc. of germanic acid solution treated with 50 cc. of 2 *N* ammonium sulphate solution, 20 cc. of *N* magnesium sulphate solution, and 20 cc. of ammonium hydroxide gave a filtrate containing 0.00012 g. of germanium dioxide, although the solution was allowed to stand for several days before filtration.

A number of attempts to precipitate magnesium germanate completely with less than 5 or 6 hours' digestion in presence of the precipitant failed.

Elevation of the temperature to boiling point increases the rapidity of the precipitation and improves the condition of the precipitate for filtration and washing.

The chlorides of magnesium and ammonium cannot be substituted for the sulphates in the precipitation of magnesium germanate, because a small amount of ammonium chloride, invariably hrougnt down with the magnesium salt, causes loss of germanium upon subsequent ignition of the precipitate, due to the volatility of germanium chloride.

Composition and General Properties of the Precipitate.

The precipitates obtained in the above preliminary experiments were collected and analysed as follows.

After ignition to constant weight by aid of a Meker burner and a blast lamp, the snow-white infusible mass was dissolved in a little dil. sulphuric acid, diluted to 50 cc. and then made approximately 6 *N* by addition of the measured quantity of conc. sulphuric acid. The acid solution was then saturated with hydrogen sulphide under pressure, and the germanium sulphide was converted to the dioxide in the usual manner and weighed. The magnesium content of the filtrate from the germanium sulphide was determined by the usual magnesuim pyrophosphate method. The following table shows the results of four analyses of the magnesium salt:

Table I.

Analysis of Magnesium Orthogermanate.

Wt. of salt taken.	GeO_2 found.	MgO found.
G.	%	%
0.1186	56.72	43.17
0.2025	56.65	43.47
0.1348	56.30	43.20
0.3823	56.20	43.82
	Mean 56.47	Mean 43.42

From these results it may be seen that the salt precipitated from an aqueous solution of germanic acid by magnesia mixture is magnesium orthogermanate. Theoretically, this salt contains 56.45 per cent. germanium dioxide and 43.55 per cent. magnesia, which values are very close to the means obtained.

Magnesium orthogermanate is a pure white, amorphous substance which shows no definite crystalline structure under microscopic examination. It is infusible at the highest temperature obtainable in the blast lamp, and is non-volatile at a white heat. A large excess of ammonium salts retards its formation, but does not prevent quantitative precipitation unless present in greater concentration than that equivalent to 25 cc. of 2 *N* ammonium salt to each 100 cc. of germanic acid solution. The precipitate is very soluble in dilute solutions of all the mineral acids and is only slowly soluble in the same acids even after intense ignition. If the excess of ammonia be boiled off, the precipitate will pass into solution in the nearly neutral ammonium salt. Reprecipitation takes place upon addition of more ammonia.

Solubility of Magnesium Orthogermanate.

An excess of the thoroughly washed salt was suspended in pure redistilled water in a platinum bottle in which it was allowed to remain for several weeks at 26°. The vessel was freqnently shaken. After filtration through a dry filter, 25 cc. of the filtrate was evaporated to dryness and ignited in platinum. The residue of magnesium salt weighed 0.0004 g., representing a solubility of 0.000016 g. per cc. at this temperature.

The same procedure was carried out using 3 volumes of water and 2 volumes of ammonium hydroxide in place of the pure water. The solubility was only slightly different, 1 cc. containing 0.00002 g.

Another portion of the magnesium salt, suspended in a 10 per cent. ammonium sulphate solution rendered strongly alkaline with ammonia, and digested at room temperature for a week, showed upon filtration, evaporation and ignition of a 20 cc. sample, a solubility of 0.00013 g. per cc.

It is evident that magnesium germanate is about ten times as soluble in dil. aqueous ammonia containing 10 per cent. ammonium sulphate, as in pure water or dil. aqueous ammonia. The presence of an excess of magnesium ion, however, reduces this solvent action of the ammonium salt well within the limits required for a quantitative precipitation.

No advantage is obtained by addition of much ammonia to the wash water, as the precipitated magnesium salt shows nearly the same solubility in both water and dil. aqueous ammonia. In all of the described determinations the wash water contained 10 cc. of ammonium hydroxide sp. gr. 0.89, to 90 cc. of water.

FINAL DETERMINATIONS.

In all of the final determinations which follow in tabular form, the germanic acid solutions were treated with the normal magnesium sulphate solution in excess, followed by at least an equal volume of 2 *N* ammonium sulphate solution. The ammonium hydroxide was always added last in amounts varying from 15 to 20 cc., for each 100 cc. of solution, while the solution was stirred vigorously, and the whole then raised to boiling for a few moments and allowed to cool and stand for 10 to 12 hours before it was filtered. The wash water, a mixture of 90 cc. of water and 10 cc. of ammonium hydroxide (sp. gr. 0.89) varied in volume with the quantity of precipitate, but did not exceed 50 cc. in any instance. Ash-free paper filters were used in every case, except Analyses 1 and 2, in which the bulky mass of precipitate was collected upon porcelain Gooch crucibles with asbestos mats. It was not necessary to remove precipitates from the filter paper. The precipitates were quickly dried and ignited with free access to air. Very little reduction takes place by action of the filter paper, and the slightly darkened surface of the ignited mass, produced by action of the carbon, rapidly oxidizes to the pure white germanate upon continued ignition. Toward the end of each ignition the precipitate was heated over a blast lamp to constant weight.

Magnesium germanate may be ignited in ing gases. The presence of filter paper, however, makes this procedure rather unsafe.

Analytically, germanium is invariably met with as sulphide, but the determination as magnesium orthogermanate requires an ammoniacal solution of the oxide. The simplest method of treatment of the precipitated sulphide consists in the addition of a slight excess of ammonium hydroxide, followed by an excess of hydrogen peroxide. Upon boiling, to destroy the excess of peroixde, the solution contains ammonium germanate and is ready for precipitation as the magnesium salt in the way described. It is scarcely necessary to remark that ordinary hydrogen peroxide often contains phosphoric acid, and that such an impurity must be absent from the reagent nsed for this precipitation. Furthermore, hydrogen peroxide prevents the precipitation of magnesium germanate, so that it is essential that the excess of peroxide used to oxidize the ammonium thiogermanate be destroyed by long boiling before the precipitation of the magnesium salt.

When arsenic accompanies germanium the 2 sulphides may be separated through the solubility of germanium sulphide in hydrofluoric acid.[2] The solution of germanium fluoride, obtained by filtration, can then be evaporated with a little sulphuric acid to expel the hydrofluoric acid, and may then be treated with magnesium sulphate and an excess of ammonium hydroxide. The presence of fluorides entirely prevents the precipitation of magnesium germanate.

It is necessary to lay emphasis upon the importance of controlling the concentration of the reagents used in the precipitation of magnesium germanate. For quantities of germanum dioxide varying between 0.5 and 0.2 g. in 100 cc. of solution, it was found best to add from 20 to 25 cc. of 2 *N* ammonium sulphate solution, together with the excess of magnesium salt (15 to 25 cc. of *N* solution). In a series of preliminary experiments it was found that lower concentrations of the ammonium salt resulted in the complete precipitation of the germanium content of the solution, but the analysis of the precipitate showed too high a content of magnesia, to correspond with the formula of the normal salt. On the other hand, a large excess of ammonium

² *Müller, Jour. Amer. Chem. Soc.*, 1921, XLIII., 2549.

salt retards the precipitation to an unnecessary degree.

Obviously, two methods of procedure can be used to prevent this source of error: (1) add the proper excess of ammonium sulphate in quantity sufficient to prevent the separation of magnesia; (2) resort to a double precipitation of the magnesium germanate similar to that commonly carried out in the quantitative estimation of magnesium pyrophosphate or arsenate; that is to say, the moist precipitate of magnesium germanate may be dissolved in dil. sulphuric acid and the solution then treated with excess of ammonia, the whole raised to boiling temperature and then allowed to cool before a slight excess of magnesium sulphate is added to complete the precipitation of the germanate.

TABLE II.

Final Determinations.

GeO_2 taken	Mg_2GeO_4 found	GeO_2 calculated from Mg salt	Vol. of soln.	GeO_2 found in filtrate
G.	G.	G.	cc.	G.
0.4308	0.7623	0.4301	135	0.0006
0.2154	0.3823	0.2158	110	0.0002
0.0136	0.0248	0.0139	75	0.0004
0.0136	0.0244	0.0137	75	trace
0.1130	0.2036	0.1148	100	0.0006
0.0006	0.0013	0.0007	40	trace
0.0013	0.0027	0.0015	25	trace
0.0005	0.0011	0.0006	30	none
0.0011	0.0018	0.0010	50	none
0.0002	0.0003	0.0001	15	trace

The final results, Table II., show that the simpler method involving a single precipitation, allows the fairly accurate determination of germanium with the escape of almost negligible amounts of germanium in the filtrate and wash water. In the method of double precipitation, results were not obtained which were in any way superior to or more concordant than those resulting from a single precipitation in the presence of the above-mentioned excess of ammonium sulphate.

SUMMARY AND CONCLUSION.

1. Magnesium orthogermanate, a compound not hitherto reported, has been prepared and its general properties described.

2. This salt is admirably adapted to the gravimetric determination of germanium in quantities ranging between 0.5 g. and 0.0002 g. The precipitation and ignition of this compound are not accompanied by change in composition or any loss by volatility.

3. Ordinary quantitative filter paper may be used and the precipitate quickly dried and ignited to constant weight.

4. The described method is considerably simpler than that of the determination as sulphide, and, the writer believes, more accurate than the well-known conversion of the disulphide to dioxide.

Philadelphia, Pennsylvania.

* *From the Journal of the American Chemical Society, November*, 1922, p. 2493.

NOTICES OF BOOKS.

Joannes Baptista van Helmont: Alchemist, Physician and Philosopher, by H. STANLEY REDGROVE, B.Sc., F.C.S., and I. M. L. REDGROVE. Pp. 86 + 1 plate. London: Messrs. William Rider &Sons, Ltd., 8-11, Paternoster Row, E.C.4. Price 2s. net.

The annals of Chemistry contain, prior to the eighteenth century, no name greater than that of Joannes Baptista van Helmont. It is surprising, therefore, that, apart from paragraphs to be found concerning works of reference, no account of his life and work has hitherto appeared in English. Mr. Redgrove, as proved by his previous contributions to the history of chemistry, is undoubtedly better equipped for dealing with the subject of van Helmont than any other living writer; he has certainly not disappointed us, and in fact the book needs no other recommendation than to say that it is from his pen. As in the case of his previous life of Joseph Glanvill, recently reviewed in these columns, in writing this book he has had the able assistance of his

Although the book is a small one, and consequently very cheap, it contains all that it is necessary for us to know concerning the life and works of the man with whom it deals; and in fact it is remarkable how much information the authors, by the avoidance of every unnecessary word, have managed to pack into so small a compass. It should be noted with approval, moreover, that full references to the original sources of information—which are, in the main, van Helmont's own writings—are given for every statement.

The book is divided into six chapters. The first chapter, which is in the nature of an introduction, briefly surveys the work of Paracelsus, whose disciple van Helmont, to a limited extent, was, and supplies the necessary historical background for what follows. Chapters 2 and 3 are biographical; and the authors well describe van Helmont's life as showing us "the conflict of light with darkness of free enquiry with tradition, of truth with dogmatism, of love with hate." Chapter 4, under the title of "Mysticism and Magic," deals with van Helmont's philosophical notions, and it is well pointed out how, in spite of much that seems fantastic, many of van Helmont's philosophical ideas are evidence of an energetic mind and show certain approximations to current thought. Chapter 5 deals with his work as a chemist. His invention of the word "gas," his investigation of *gas sylvestre* (carbon dioxide) and other gases, his researches on silica and other experiments in which he came, as the writers say, "within an ace of realising not only the true nature of a chemical element . . . but also the law of its persistence," his views concerning the First Matter, which, although erroneous, led to some very interesting experiments, and finally his experiments in transmutation are all adequately dealt with. Van Helmont's account of how he effected the transmutation of mercury into gold by the aid of an unknown powder is amongst the most remarkable in all alchemical literature. The writers point out the difficulties of either explaining this story, or explaining it away, and wisely refrain from any note of dogmatism. The final chapter deals with van Helmont's medical theories, and reviews at some length his contributions, which were considerable, and in many cases of much value, to physiology, pathology, and therapeutics.

J.G.F.D.

New Patents.

This list is specially compiled for the *Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

31248—Goldschmidt Akt. Ges., T.—Production of amorphous finely-subdivided litharge. Nov. 15.

31254—Imray, O. Y.—Manufacture of azo dyestuffs. Nov. 15.

30933—Jacobson, B. H.—Manufacture of aluminium chloride. Nov. 13.

31257—Perim, H.—Process for manufacturing dioxuperylene. Nov. 15.

31211—Spence, H.—Production of aluminous compounds. Nov. 15.

31977—Becco Engineering & Chemical Co.—Treatment of waters containing alkaline bicarbonates. Nov. 22.

32080—Bloxam, A. G.—Manufacture of azo dyestuffs. Nov. 23.

31877—Braithwaite & Co.—Crystallization of matter in solution from liquids. Nov. 22.

31685—Edwards, G. W.—Treatment of oxidized ores. Nov. 20.

32134—Nicholson, T. — Neutralizing ammonium sulphate. Nov. 24.

31791—Wagner, W. G.—Extraction of metals from their ores. Nov. 21.

Specifications Published this Week.

188045—Goss, H. W.—Apparatus for chlorinating water or other liquid.

169962—Melamid, Dr. M.—Process for the manufacture of substances of the fatty-acid type.

171970—L'Air Liquide Soc. G. Claude.—Synthesis of ammonia.

186558—Richowsky, F.—Processes of producing titanium nitrogen compounds.

Abstract Published this Week.

B-Thionaphthisatin.—Patent No. 186859. — The Soc. of Chemical Industry of Basle, Switzerland, has obtained a Patent in this country for a process for preparing B-thionaphthisatin.

The product is obtained by the reaction of oxalyl chloride on B-thionaphthol in the presence or absence of diluents or condensing-agents. According to the examples, B-thionaphthol is boiled with excess of oxalyl chloride, boiled with oxalyl chloride in carbon bisulphide solution, with or without further treatment with aluminium chloride, or treated in the cold with oxalyl chloride in the presence of concentrated sulphuric acid.

Messrs. Rayner & Co. will obtain printed copies of the published Specifications, and forward on post free for the official price of 1s. each.

THE CHEMICAL NEWS,

VOL. CXXV., No. 3722.

APPEAL FOR MEDICAL AID FOR RUSSIA FROM DR. NANSEN'S COMMITTEE.

To the Scientists and Medical Men of the World.

Following on the Great War, the Civil War, and the long blockade, Russia has passed through a famine the like of which has not been known for centuries. One-third of the vast area of Russia is affected by the famine, a population of thirty-five million is stricken, and death has carried away millions of victims. Famine has wiped out both rural and urban populations; the peasants—the producers of grain for the world market—have died; whole nations, inhabiting the stricken regions, have vanished, and children, the hope of the future, have died out elsewhere. The horrors of famine have driven the inhabitants to fly, leaving their homes, deserting their cattle and fields. Whole villages have been ruined, the households left without furniture and without cattle. Factories are idle; the number of unemployed is growing, thousands of children have been left homeless.

Russian medical personnel, being cut off from the rest of the world in remote villages and townlets, amidst thousands of sick and starving people, has been quite helpless in this great calamity; yet they have heroically borne their burden and carried out their duty, despite the imminent danger of death. Infirmaries, and in particular Emergency Medical Treatment centres, organised with great effort, have had to be closed down owing to the lack of drugs and medical stores, and thus the struggle with the effects of famine is left entirely to the Russian medical personnel themselves. The exhausted and weak population of the affected regions fall easy victims to all kinds of epidemics which threaten not only Russia but the whole of Europe.

The lives not only of the present generation, but of those of the future, are in danger.

The necessity of immediate and energetic aid is imperative. But Russia by herself is powerless.

We therefore appeal in the name of humanity and international solidarity, to the Scientific World of Europe and America, and we are sure that our appeal will meet with a generous response from the scientists and medical men of the world.

The sanitary and biological effects of the famine will be felt for a long time to come, and not only in Russia, but in Europe as well. The Russian famine confronts the Scientific World as an exceptional sanitary and biological problem, for the solution of which all the forces of science and medicine need to be concentrated.

And how should this assistance be given?

In every country, in each division of the country, and in all the larger centres, a Committee of Medical Relief to fight the effects of the famine in Russia should now be organised.

All the medical committees should be united in an International Committee for medical aid to fight the effects of the famine in Russia, under the presidency of Dr. Nansen.

The programme of the work of the international fight against the consequences of the famine must comprise:—

(1) A well-directed agitation for the recognition of the Russian famine as an international sanitary and biological calamity.
(2) Appeals to Governments.
(3) To the people of the different countries.
(4) Appeals to the scientific and medical workers of the whole world.
(5) The collection of money.
(6) The organisation of help in the way of medical equipment, medicines, and sanitary articles, and means for organising medical institutions in the affected areas; as well as
(7) the scientific study of famine from the sanitary and biological aspect.

The principle of international scientific and medical solidarity was a fairly well established achievement of the pre-war period. Now, after the terrible world war, which has led to a number of grave social catastrophes and calamities, including the Russian famine, that solidarity must come again into active existence.

Contributions in money should be sent to Treasurer, Medical Aid Committee, London Joint City & Midland Bank, 6, Chancery Lane, W.C.2. They will be acknowledged by the Bank.

Contributions in kind should be sent to Secretary, Medical Aid Committee, 68, Lincoln's Inn Fields, W.C.2, and will be acknowledged by the Secretary.

MISSING ELEMENTS IN THE PERIODIC TABLE.

(PART II.).

By F. H. Loring.

In this Journal of Nov. 24th (vol. CXXV., p. 309) the above subject was discussed, and certain conclusions were arrived at, but further information on the subject seems desirable in order to strengthen the deductions so far made.

In this extension of the original paper, a new study by two American authorities is introduced, and this may be of general interest. The Periodic Table herein developed, which is based upon the previous one given, may be considered from the chemical as well as from the physical side.

Recapitulating, in particular it was shown that the exceedingly small quantities of scandium relative to the quantities of those elements on either side of it made it possible to formulate a "series" which seems to indicate that certain elements either do not exist, or if they do, the quantities to be discovered are exceedingly minute.

Now F. W. Clarke and H. S. Washington, of the United States Geological Survey, have made an investigation of the average percentage composition of the earth's crust down to radial depths of 10 and 20 miles, and of course the term *crust* may be taken, where the context admits, to include the atmosphere and the waters of the oceans and seas.

These investigators, on analysing over 5,100 samples, found a great preponderance of oxygen, silicon, aluminium, iron, calcium, sodium, potassium, and magnesium over the other elements present. To give expression to their findings, as thus far recorded (further publication is to be expected), use will be here made of the data given in an article by T. Crook, which appeared in *Nature* of August 19, 1922 (p. 253). To this end, Table IV. herewith is given, which agrees with Crook's table except that the extreme decimal fractions above barium are rounded off to the nearest figure, so as to reduce the labour in setting up the type, for the evaluations are sufficiently approximate to justify so doing.

In this Table, Column I. is the average composition of a ten-mile crust comprising the atmosphere and hydrosphere; Column II. is similarly the average composition of a twenty-mile crust comprising the atmosphere and hydrosphere; Column III. is the average composition of a ten-mile crust of igneous and sedimentary rocks; while Column IV. is the average composition of ten miles of igneous rocks. For further particulars, see Crook's article, and the original paper which appeared in the *Proceedings of the National Academy of Science*, 1922, vol. VIII., p. 108.

TABLE IV.

Element	I.	II.	III.	IV.
Oxygen ...	49.2	47.8	46.7	46.4
Silicon ...	25.7	26.7	27.6	27.6
Aluminium	7.5	7.8	8.0	8.1
Iron	4.7	4.9	5.0	5.1
Calcium ..	3.4	3.5	3.6	3.6
Sodium ..	2.6	2.7	2.7	2.8
Potassium	2.4	2.5	2.6	2.6
Magnesium	2.0	2.0	2.1	2.1
Hydrogen	0.88	0.50	0.14	0.13
Titanium .	0.65	0.68	0.70	0.72
Chlorine .	0.23	0.16	0.10	0.10
Phosphorus	0.14	0.15	0.15	0.16
Carbon ...	0.14	0.10	0.15	0.05
Manganese	0.11	0.12	0.12	0.12
Sulphur ..	0.10	0.09	0.10	0.08
Barium ...	0.075	0.078	0.079	0.081
Chromium	0.062	0.065	0.066	0.068
Zirconium	0.048	0.050	0.052	0.052
Vanadium	0.038	0.040	0.041	0.041
Strontium	0.032	0.034	0.034	0.034
Fluorine ..	0.030	0.030	0.030	0.030
Nickel	0.030	0.031	0.031	0.031
Nitrogen .	0.030	0.016		
Cerium, Yttrium	0.019	0.020	0.020	0.020
Copper ...	0.010	0.010	0.010	0.010
Lithium ..	0.005	0.005	0.005	0.005
Zinc	0.004	0.004	0.004	0.004
Cobalt	0.003	0.003	0.003	0.003
Lead	0.002	0.002	0.002	0.002
Boron ...	0.001	0.001	0.001	0.001
Beryllium	0.001	0.001	0.001	0.001
About ..	100%	100%	100%	100%

Crook comments on the above results as follows: "A serious defect in the method of procedure on which the above estimates by Clarke and Washington are based is that it makes no allowance for the relative magnitude of the different kinds of rock of which the lithosphere is composed. They admit this defect, but claim that any erorrs involved are likely to be compensating (*Journ. Franklin Inst.*, 1920, vol.

THE WEDGE PERIODIC TABLE OF THE ELEMENTS
(BASED ON ATOMIC NUMBERS AND ATOMIC LEVELS)

THE ATOMIC NUMBER OF THE INERT GASES **A** IS GIVEN BY RYDBERG'S SERIES EQUATION. $A = 2(1+2^2+2^2+3^2+3^2+4^2 \ldots)$, BY STOPPING OFF AT EACH SQUARED TERM THUS —

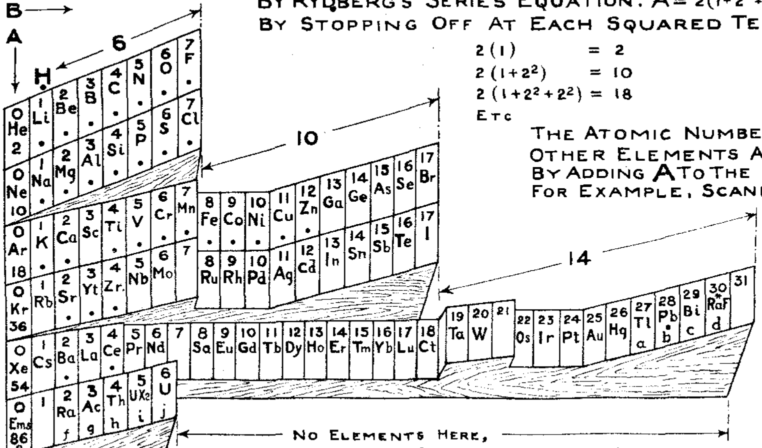
$2(1) = 2$

$2(1+2^2) = 10$

$2(1+2^2+2^2) = 18$

ETC

THE ATOMIC NUMBERS OF ALL THE OTHER ELEMENTS ARE OBTAINED BY ADDING **A** TO THE **B** NUMBERS. FOR EXAMPLE, SCANDIUM IS 3 + 18 = 21.



THOSE ELEMENTS OCCURRING IN GREATER ABUNDANCE ON THE EARTH ARE INDICATED BY A BLACK SPOT

AND EXCEEDINGLY SMALL QUANTITIES OF ELEMENTS, OR IN SOME CASES NONE, WILL OCCUPY PLACES BEARING ATOMIC NUMBERS, 21, 43, 61, 75, 85, 91, 93; FOR THESE NUMBERS GIVE DIFFERENCES OF A LIMITING SERIES THUS —

21	22
43	18
61	14
75	10
85	6
91	2
93	

THE SMALL QUANTITIES OF SCANDIUM AND URANIUM X_2 RELATIVE TO THE RESPECTIVE QUANTITIES OF OTHER ELEMENTS ON EACH SIDE OF THEM GIVE SUPPORT TO THIS VIEW.

THE RADIO-ELEMENTS FIT INTO PLACES a, b, c, ETC., AS ISOTOPES OF THOSE INSERTED TO CHARACTERISE THE PLACES.

EMS. = EMANATIONS.

ATOMIC NUMBER OF H = 1

* OR POLONIUM Po

CXC., p. 770)." However this may be, the percentages given can no doubt be taken as an approximation to the truth in many cases.

It will be seen from this table that there is roughly almost as much calcium as iron *in the earth's crust.* Similarly, there is *more titanium than hydrogen.* These two *elements (Ca and Ti) fall* next to scandium, so that in *all* probability the statement that scandium is present in *relatively* small quantities is justified.

Reference was made in the original paper, by the present writer, to a Wedge Type of Periodic Table. This Table (V.) is *here produced* in a *complete form* with *accompanying explanatory data*; and the elements of Table IV. are indicated thereon by black spots, so that those which are more abundant may be seen at a glance.

In studying the relations shown, it will be seen that the position of hydrogen is fixed by the concurrence of three significant differences, as given in the series underneath the Table. This observation by itself would not have sufficient weight to become a determining factor, since it might be a chance coincidence, but when further factors are taken into account (see my "Atomic Theories," chapter XX., p. 151), the position of hydrogen over lithium appears to be in many respects a satisfactory one, though the artificiality of all classifications must be kept in mind. Nature did not evolve the elements to fit a given preconceived periodic table. The periodic scheme is man's epitome of the resultant effect of the working of various laws or forces in which *periodicity of action* seems *prominent*, and its *constructional* artificiality is apparent in the sense intended.

Table V.

The term, *Atomic Level*, should not be confused with the level often referred to in analysing the electron rings or shells of the atoms by means of X-rays; for the K, L, M, N series of lines are supposed to originate respectively in, or in connection with, different energy levels. There may be a relationship between these two ideas (they may be two aspects of one and the same thing), but until such a relationship is clearly established it is better to treat them as different factors in atomic physics. The "levels" given in the present Table (V.) are not intended to be final as regards adjustment, as this would entail a very ... chemical properties *of some of the elements of the rare-earth* series about which very *little* is known.

Summary.

The relative distribution of elements in the earth's crust, according to the findings of Clarke and Washington, is tabulated and shown to support the view that scandium exists in relatively small quantities *compared with the quantities of Ca and Ti situated on each side of it in the periodic* table, and this fact strengthens the conception of a significant atomic-number series, thereby earmarking the periodic places where no elements can fall, or if they do fall into such places the quantities will be exceedingly minute. The wedge *type of periodic table involving atomic levels as well as atomic numbers is illustrated* by a perspective drawing. In this connection, the position of hydrogen over lithium is fixed by the coincidence in two number-sequences shown in the Tables.

November 29th, 1922.

ROYAL INSTITUTION OF GREAT BRITAIN.

Weekly Evening Meeting, Friday, April 28, 1922.

Sir James Reid, Bart, G.C.V.O., K.C.B., M.D., LL.D., Vice-President, in the Chair

Arthur Harden, D.Sc., F.R.S.

Vitamin Problems.

[Abstract.]

The existence of three vitamins, termed A, B, and C, has now been firmly established, and a general idea has been obtained of their distribution among animal and vegetable organisms. Hitherto, comparatively little quantitative work has been done in this direction, and further progress must depend on a more general adoption of quantitative methods. These are at present tedious and not very accurate. In the case of each of the vitamins the requirements of the special animal employed serve as the unit of comparison, and these vary considerably from individual to individual, so that many observations are necessary if any, even moderate, degree of accuracy is to be attained. Thus in the estimation of the antiscorbutic potency of food materials, by the method worked out by Miss Chick and her colleagues at the Lister Institute, it has seldom been possible to achieve a greater accuracy than about 25-50 per cent.

This obviously imposes a very serious limitation on any attempts to study variations in potency unless these are of a very gross order. Another great difficulty inherent in this kind of observation is that when the potency is low, the necessary dose of the material to be tested is correspondingly high, and soon transcends what is permissible without interference with other necessary conditions of the diet, such as protein content, etc. Very much the same conditions hold with regard to Vitamin B, especially when this is estimated by the effect of the material on the growth of rats; and, as a matter of fact, the great bulk of the work carried out in America by this method is not strictly quantitative, but simply leads to the result that a certain ration does, or does not, suffice for the growth of a young rat.

As regards Vitamin A, the method of Zilva and Miura promises to yield moderately accurate and consistent results. This is attained by keeping the experimental animals (young rats) on a diet totally deficient in Vitamin A until they have ceased to grow, and then ascertaining the minimum dose of the material to be tested which will induce definite and steady growth for four weeks. Animals which do not cease to grow in three weeks are rejected, greater uniformity in the results being thus attained. The test material is, whenever possible, administered quantitatively to the animal, and not, as was formerly the practice, mixed with the ration in a known proportion. One of the immediate results of the application of this method has been the discovery that cod-liver oil, formerly classed with butter as a good source of Vitamin A, is in reality 200-250 times as potent as butter, and is, along with similar fish-liver oils, by far the richest in this material of all the substances which have so far been examined.

A further piece of information, which is essential for the detailed study of these substances, is their behaviour towards heat, oxidation, etc. In this respect some progress has been made, and it may be stated with some confidence that both Vitamins A and C are moderately stable towards rise of temperature, provided that air be excluded, whereas in the presence of air they are rapidly inactivated. Whether the effect of air is reversible or not has not yet been ascertained. Vitamin B, on the other hand, appears not to be affected by air, and is also moderately stable towards rise of temperature. None of the three vitamins is easily inactivated by hydrolysis under anærobic conditions, and this fact has led to the interesting observation that Vitamin A, although usually associated, in the animal organism, with fat, is not itself a fat but remains in the unsaponifiable residue with almost unabated potency. This indicates how small a weight of the vitamin itself is necessary for the daily ration of a young rat. In some cases as little as 1.2 milligram of the oil is sufficient to permit of definite growth, and of this only 1-2 per cent. is unsaponifiable, while, as is well known, the chief constituent of the unsaponifiable matter is cholesterol, which has itself no vitaminic potency. The actual requirement of the vitamin itself must therefore be of the order of 1/500 milligram per diem. The other two vitamins have not been obtained in so concentrated a form, but it appears highly probable that they, too, are present in foodstuffs only in infinitesimal amounts.

The origin of all three vitamins is to be sought in the vegetable kingdom. The production of Vitamin A has been followed (Coward and Drummond) from the seed, and it has been found that it does not appear until the photosynthetic processes begin. Thus sunflower seeds are almost devoid of it, and so are the etiolated seedlngs formed when these seeds germinate in the dark. In the light, on the other hand, the green seedlings, grown in a medium free from the vitamin, produce it freely. This vitamin is often closely associated with the carotene and xanthophyll of plants; so intimately indeed, that it was at one time thought that it might be closely related to, if not identical with, one of them. The association, however, although very frequent, is not essential, and no definite relation can be shown to exist between the two. Vitamin C is either absent from seeds or only present in them in very minute amount, but appears when the seed germinates and before any green parts are formed. Nothing is, however, known of the inactive pro-vitamin or of the process by which it is rendered active.

Concerning the origin of Vitamin B, a considerable amount of discussion has taken place. Its presence in a large proportion in yeast points to the probability that it can be produced without the intervention of light, and both in America and in this country it has been found that yeast can actually porduce the vitamin when grown in a

" synthetic medium " comprising only substances of known composition and free from the vitamin in question. Recently, however, Eijkman, in Holland, has obtained a contrary result, so that at the moment this remains an open question.

The animal organism appears to be unable, in normal circumstances, to produce any of these principles for itself, and hence the amounts found in animal products depend ultimately on the diet of the animal. This opens up, among many other problems, the important question of the vitaminic properties of milk, and there seems to be no doubt, from experimental work, both here and in America, that these properties are profoundly affected by the diet of the cow. Milk obtained in winter when the animals are stall-fed has been shown to be markedly deficient in Vitamin A, and there is also great danger of a deficiency of Vitamin C. One of the pressing requirements of the moment is the careful quantitative examination of foodstuffs available for the feeding of cattle, so that a rational system of winter feeding can be adopted which will produce milk as good as that given in summer. Such an examination would seem naturally to fall within the purview of the Board of Agriculture.

The evil results of a deficiency of Vitamins B and C, especially in the diet of children, are well known—beri-beri and scurvy, latent or patent—but the effect of a lack of Vitamin A is not so well recognised or so universally acknowledged. One school considers that a deficiency of this vitamin is at least a prominent factor in the causation, if not, as they formerly held, the sole cause of rickets. Others consider rickets to be a disease brought on by non-hygienic surroundings, lack of fresh air and exercise, etc. The latest experimental results show that rickets (in rats) can be produced infallibly by dietetic changes, but that the lack of Vitamin A does not of itself lead to the disease unless at the same time the diet is faulty as regards the supply of calcium or phosphorus. This faulty mineral supply does not usually lead to true rickets if suficient Vitamin A be present, although the bone formation under these circumstances is not quite normal. This explains the well-known curative effect of cod-liver oil in rickets. So marked is the effect of this remedy, that McCollum, not appreciating the relatively enormous concentration of Vitamin A present in it compared with that in butter, as proved by Zilva, has suggested that cod-liver oil contains some other specific substance absent from butter, to which its great superiority is due. The difference, however, seems to be merely quantitative, and the further complication suggested by McCollum appears to be unnecessary.

These experiments on rickets have led to what promises to be a discovery of far-reaching importance. Rats on a diet, which in the laboratory will infallibly produce rickets, do not acquire the disease if they are exposed to sunlight in the open air or to ultra-violet radiation, and rats which have acquired the disease can be cured by either of these treatments, just as they can be cured by the administration of cod-liver oil. Sunlight and ultra-violet radiation have also been found to be effective cures or preventives of rickets in children. The cures by light and by cod-liver oil seem to proceed in precisely the same way, and the idea naturally suggests itself, especially to the mind of a chemist, that the light actually brings about the synthesis of the vitamin in the animal body just as it does in the plant. This idea still awaits experimental verification or disproof; but there is no doubt that this function of light will lead to profoundly important developments in our knowledge.

[A. H.]

COLLOIDS IN GEOLOGIC PROBLEMS.*

By George D. Hubbard.[1]

Introduction.

It has long been recognised that solid matters occurs in more than two states. The terms "crystalline" and "amorphous" exclude quite a large body of materials, some of which are organic and some inorganic. The other condition has been called the colloidal state. Many substances which occur crystalline can be prepared in the colloidal state without any compositional

* *From the American Journal of Science, August, 1922, p. 95.*

[1] *The author is deeply indebted at man[y] points in the paper to Dr. Harry N Holmes, of Oberlin College, for suggestion[s] and criticism. His General Chemistry an[d] Colloid Manual have been of much hel[p] also. This paper was presented to the Geo[logic] Section of the Ohio Academy o[f] Science, April 15, 1922.*

difference. Amorphous substances were in many instances once in colloidal condition. Perhaps all substances can ultimately be prepared in this state, whether they are normally crystalline or amorphous.

In the case of some substances, there seems to be no line fixed between the crystalline and the colloidal state. In the same way, there seems to be no line which can be definitely drawn between a true solution and a colloidal solution. In practice we say a substance is in the colloidal state when it will not dialyze or diffuse through certain membranes, as egg skin, bladder, goldbeater's skin, or parchment paper. Molecular dispersions are in true solution; dispersions of much larger aggregates (a hundred, more or less, of molecules in one particle) are in colloidal solution. Such particles are too large to pass through the membrane.

Bancroft[2] says, "Colloid chemistry is the chemistry of grains, drops, bubbles, filaments, and films." Grains of solid particles, drops of fluids, bubbles of gas, filaments very small in two directions, films small only in one direction—these constitute the field of the student of colloids. The smallest particle visible with the aid of the best compound microscope is about 100 millimicrons in diameter, while the largest molecules approach a diameter of 1 millimicron. Materials in the colloidal state have particles ranging between these limits.[3]

The term "colloid" or "colloidal state" has been expanded to include not only solid gels, but suspensions and emulsions. The former may be solids in liquids, as the very fine sediments in turbid water, liquids in liquids, or even solids in solids, as the blue rock salt which is a suspension of finely divided metallic sodium in crystalline halite. In suspensoids the solid particles do not powerfully absorb or hold large quantities of water. In emulsoids, on the other hand, the particles very powerfully hold or absorb large quantities of water, forming gels. Such gels have been made solid, containing as high as 99.87 per cent. water.

Gels are substances in the colloidal state which have set or become apparently solid, even though they contain a large percentage of water. The fruit juice (acid), water, and sugar in the jelly cup have set because of a small percentage of pectin. All are essential to the phenomenon. Certain minerals, for example most orthosilicates and some zeolites, on some evaporation after solution in hydrochloric or nitric acid, will set in beautiful gels because of the silicic acid liberated. Sodium silicate or water glass sets in the same way when treated with acetic or some other acid, which makes a salt with the sodium and leaves the silica to gel.

As early as 1861 Thomas Graham[4] knew that dissolved crystalline substances diffused in and out of silica gels, and that reactions occurred between salts in solution in the gels and solutions from outside which diffused in. The famous Liesegang rings were discovered in 1896. Many of these were rings of metallic crystals or crystalline salts, formed in silica gels by reactions between two solutions, one of which was in the gel and the other was gradually diffusing through the gel. The well-developed crystal had time to form because the solutions came in contact so slowly. Bechhold in 1905, Ziegler in 1906, and Hatschek in 1911 continued experiments with rings in gels.

Mineral Genesis Through Colloidal State.

Liesegang suggested after his studies on the rings in gels that the banding of agates might be due, in many cases, to the slow diffusion of iron salts through silicic acid gels which had previously been laid in cavities or crevices. He also suggested that this process might explain the formation of large crystals in or on quartz in places where igneous activity had not operated, and where they therefore could not be due to its heat and gases.

In the discussion at the Academy meeting, two points were made. Prof. G. F. Lamb reported orally the finding of good agates in recent clays; the data seem to be wanting as to whether they developed in pre-existing cavities or made their own spaces. Agates in the major cavities of buried bones testify to the recency also of agate-making, and as well to the rate of making. Long ages are not necessary. No evidence was presented as to whether or not the agates came through the gel stage, or how the banding originated.

[2] *Bancroft, W. D., Applied Colloid Chemistry*, p. 2 (*McGraw-Hill Co.*).

[3] *Holmes, H. N., Colloid Chemistry*, 1922 (*Wiley and Sons*).

[4] *Hatschek, E., and Simon, A. L., Trans. Inst. Mining and Metallurgy, London*, 1911-12, XXI., 451-480.

As early as 1884, Clarke tells us, Bourgeois[5] made opal synthetically from gels of SiO_2. Clarke[6] states also that the gelatinous silica formed by the solution of silicates in mineral acids becomes, upon drying, an amorphous mass essentially identical with opal. He also reports that Schafhäutl heated a solution of colloidal silica in a Papin digester and obtained a crystalline deposit of quartz; while de Senarmont heated gelatinous silica with water and carbonic acid gas to temperatures between 200° and 300° C. and obtained a crystalline quartz. Chrustschoff, 1873, obtained quartz from an aqueous solution of colloidal silica by heating to 250° C. for several months. The heat apparently hastened the process, which would have reached the same end in a longer time without so much heat. Silica is dissolved when silicates decompose, and is redeposited by evaporation as opal if still in an acid solution, but when alkalies are present it crystallises.

When the Simplon tunnel in central Switzerland was put through the Alps, the engineers found a vein of silica in the gel condition or colloidal state, thus showing that the silica gel is not purely an artificial product. If the ancient scientists who gave the name "quartz" to rock crystal had found this vein and watched it through its transformation to crystalline quartz, they might have had some ground for their theory that it was made of water which had become so thoroughly frozen in a very cold winter that its solid state had become permanent.

The experiments of Liesegang, and of many other colloid chemists who have followed him, suggest a method for the formation of the quartz-gold vein. They have shown that if a gold solution, *e.g.*, $AuCl_3$, is mingled with a silica gel when the latter sets, and then is treated with a reducing agent diffusing through the gel, crystals of gold will form in the gel. Oxalic acid placed on top may serve as this reducing agent. H_2S in water, SO_2, or CO will serve the same purpose. Sodium sulphite, and especially $FeSO_4$, do occur in solutions in nature and would be suitable reducing agents there.

Holmes[7] has shown that a preparation of silicic acid gel made 0.1N with respect to potassium iodide, and then covered with 0.5N mercuric chloride, gives in the gel after a few days bands of red crystalline mercuric iodide. In some cases as many as 40 rather sharply marked bands occurred in a distance of 8 cm. In a similar manner, bands of copper chromate, cuprous oxide, basic lead iodide, basic mercuric chloride, and other substances were formed. Bands of colloidal gold with scattered crystals of gold developed in a preparation of gold chloride and H_2SO_4 with oxalic acid above the gel.

If the silica gel were in one crevice and an intersecting crevice should be conveying one of these reducing solutions, the conditions of the laboratory would be very nearly duplicated. The only difference would be that the solution need not become continually more dilute, but might remain essentially the same in composition for years. In such case there might be no occasion for the banding of the salts, or if bands developed, they would no doubt be evenly spaced. Banding is explained[8] as a result of a reduction in concentration of the solution in the gel just in front of the ring, so that the diffusing solution must needs go beyond the clear space to find sufficient concentration for the development of another band. If the flowing solution remain constant in quantity and condition, would not the bands maintain uniform spacing instead of becoming farther and farther apart as in the laboratory experiment?

The laboratory experiment also throws light on the formation of metallic copper in quartz veins. The experimentor used a silica gel dialyzed with acetic acid (sulphuric would have served the same purpose), and mixed with his gel, before it set, a solution of copper sulphate. The reducing agent was placed on top, and the tiny tetrahedrons of metallic copper began to shine in the gel. If the gel was free from aid or any oxidizing agent, the crystals preserved their copper lustre, but without due precautions; they oxidized dark to black. Clusters and chains of tetrahedrons formed as the process continued. After many months this process produced a silica gel vein with appreciable quantities of

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[5] *Bourgeois, L., Production of Minerals artificially, p. 93 (in French).*

[6] *Clarke, F. W., Data of Geochemistry,* [illegible]

[7] *Holmes, H. N., Jour. Amer. Chem. Soc.*, 1918, XL., 1187-1195.

[8] *Holmes, ibid.*

metallic copper disseminated through it. If one wishes to repeat or extend this work, Prof. Holmes[9] has given full directions for preparing silicic acid gels.

In these cases, all that is necessary to make the typical mineralised quartz vein is to allow the gel to crystallise, a change which has already been explained as a laboratory experiment, and which seems perfectly possible as a natural geologic phenomenon.

Limonite seems to furnish an illustration of an ore once in a colloidal state. There are six hydroxides of iron, made by combining one to six molecules of water with the ferric oxide, only one of which, goethite, is known in the crystalline form. This is the hydroxide with one molecule of water to one of Fe_2O_3. Clarke, in the "Data of Geochemistry," p. 531, quotes Van Bemmelen as saying that probably no formulæ should be given to any of these ferric hydroxides, but rather they should be regarded as polymers of the first, or colloidal, complexes of two or more polymers. Van Bemmelen in a number of papers published between 1888 and 1904 so regards them, and Nicolardot and Spring both consider the several hydroxides polymers of the first. Thus the ferruginous slimes in bogs and around springs, and sometimes in stalactites in caves, as at Mount Tabor or Reame's Cave, Ohio, many of which are precipitated by organic agencies, are truly colloids which may in the course of time be dehydarted and pass over into the crystalline goethite, or even into hematite.

Some bauxite was formed by passing through a colloidal state. Colloidal alumina is soluble in water and has been carried some distance before coagulation has taken place. The coagulation is a result of the meeting with electrolytes in solution, whose charge is different from that of the colloid, and therefore the alumina loses its negative charge; the solution first becomes turbid, then the hydroxide actually flocculates and collects into larger and larger lumps, and finally falls to the bottom. Apparently the continued growth of these lumps by the successive addition of layers of aluminium hydroxide builds up the oolitic and pisolitic bodies of typical bauxite. Some banxite is certainly not of this origin.

[9] *Holmes, H. N., Silicite Acid Gels, Jour. Phys. Chem.*, 1918, XXII., 510-519.

These gel ores of iron and aluminium start by decomposition of silicate rocks in the weather zone. Descending waters carry them down into other rocks, or surace waters carry them away to marshes and bogs where the precipitating conditions are found, and the ores are dropped. In the cooler, higher latitudes the iron ores are formed, while the alumina and silica remain together[10]; and in the warmer or sub-tropical climates the laterites or bodies of bauxite are formed. Thus the ore deposit may witness to the character of the climate in force when the deposit was made. The precipitation in other rocks would probably take place above the water table; hence in high and dry regions there would be a long vertical range for deposition, which could take place anywhere between the surface and the water table.

It has been pointed out by Krusch[11] that the manganese oxides may also be laid down as gel ores, and subsequently become crystalline. He makes a point also of the fact that this colloidal ground mass of manganese oxides and hydroxides is capable of adsorbing other substances which may permeate it, *e.g.*, barium and potassium compounds. In this way, he accounts for psilomelane, a manganese mineral containing barium and potassium. F. W. Clarke, in his "Data of Geochemistry," p. 533, accepts psilomelane, and some other less known manganese ores, as colloidal complexes. In this connection he also mentions lampadite, a cupriferous hydrate of manganese. The copper may be present simply by adsorption.

The silicate nickel ores have always been a confusing group, but an interpretation involving colloidal substances seems to simplify the matter. It will be remembered that these ores are hydrous magnesium nickel silicates. The non-metalliferous foundation seems to have accumulated first as a gel,[12] and subsequently to have adsorbed some nickel compound, perhaps nickel silicate, and a magnesium compound, and thus a mixture of two substances occurs whose proportions may vary greatly within short distances.

[10] *Schlösing, T., Compt. Red.*, 1901, CXXXII., p. 401.

[11] *Krusch, P., Mining and Scientific Press*, 1913, CLXX., 418.

[12] *Krusch, P., loc. cit.*

COAGULATION OR FLOCCULATION OF SEDIMENTS.

It has long been known that even the finest sediments which come out to the sea in the waters of our great rivers fall to the bottom long before they get far into the sea, and that the main body of the ocean is made of comparatively clear water. This speedy precipitation of sediments has also been ascribed to the saltiness of the sea, but the connection had not been worked out until recent studies in colloids and their relations to electrolytes.

An electroylte is a salt, or in some cases a base or an acid, in water solution through which electric current flows. Salts are generally better electrolytes than acids. The theory is that the electrolyte is ionized, e.g., sodium chloride becomes $Na+$ and $Cl-$ in solution, magnesium chloride becomes $Mg++$ and $2Cl-$ in solution. The higher the valence of the base part of the salt (the positive ion), the more powerful the electrolyte, as a coagulant of negatively charged suspensions, and the power seems to bear no definite relation to the valence. Aluminium chloride, for example, is hundreds of times more potent than sodium chloride. The charge on the electrolyte and on the colloid must be of opposite sign. The aluminium ion of $Al_2(SO_4)_3$ has a positive charge, and aluminium is trivalent in the sulphate. Since most colloids are negative, aluminium sulphate is one of the most effective flocculators.

These salts are all three in the sea. The sodium chloride makes up fully 3/4ths of all the salts there, while the alum constitutes a very small fraction of one per cent., but because of its greater activity, it may be as efficient as the much more abundant sodium chloride. For our purposes, however, it is not material which does the work. A much more important question is, how long have the seas been salt enough to coagulate the fine clays in colloidal suspension as they come down? We have shale rocks made of such clays of all ages back through the Mesogoic, Paleozoic, and perhaps well into the Proterozoic. Such clays, of course, would settle out of quiet waters without the assistance of an electrolyte, but such waters certainly would be difficult to find on the continental shelf. Therefore we may safely assume that these shales made of extremely fine clays were largely precipitated by electrolytes, and that the sea was salt enough in those Proterozoic days to effect their coagulation.

Experiments show that one per cent. sodium chloride solution will coagulate clays rather quickly and that one-tenth per cent. alum solutions will bring them down in a few hours, so we need not assume that the sea had a greater saltiness than, say, 25 per cent. of its present salinity in order to bring down the clays. In this connection it may be interesting to note that the age of the ocean has been calculated on the basis of the NaCl in the water, assuming essentially the same rate of inflow as at present, and only trifling losses as compared with the present salt in the sea. The latter assumption is easily established. The former is probably safe. Dividing the rate by the amount of salt in the sea, Chamberlin and Salisbury arrive at the figure of 370,000,000 years. If anything like one-fourth the present saltiness would be necessary before effective precipitation should take place, then these old shales may be at least 250,000,000 years old, a much larger figure than usually given by geologists for the period since early Proterozoic. On the basis of these figures they may not be more than 300,000,000 years old. Pirsson and Schuchert's geology gives 80-90 instead of 370 million years.

Many colloidal suspensions, like those in the muddy waters of lakes, owe part of their stability to the fact that their particles all carry like charges. Of course, the movements of the waters help to keep the particles up, but in spite of the movements, electrolytes will bring them down, so it seems probable that the electric conditions are as significant in suspensions as is the agitation of the water. If the particles of the colloidal material, and other substances in the solution are similarly charged, the tiny pieces of the colloid do not fall.

Even when waters are allowed to stand as still as they can in a laboratory, some of these colloidal suspensions do not clear up in months. It is believed that the particles are so small that their own Brownian motion prevents them from clinging together into flocculent masses large enough to fall through the water. Stokes' formula gives the following relation:—

$$V = 2r^2g/9k.(d-d')$$

V is the velocity of fall of spherical particles of radius r; k is the viscosity of the fluid; d' and d are the densities of the fluid and the particle respectively, and g the acceleration due to gravity. If water and the

same kind of particles are used on the same table for experiment, the variables all drop out but r.

Theoretically, then, the rate of fall cannot quite be zero, and permanent suspension becomes impossible if the particle is denser than the medium, but practically, since V varies with the square of the radius, we can find particles so small that their fall would be so slow that convection currents and Brownian movement would be ample to keep them up. When two or more coagulate together, their Brownian kicks are proportionately much smaller, and the particle begins to descend. Protecting films of gelatine or other substance which does not mix readily with the medium may surround each suspended particle and prevent its cohering or coalescing with others into masses large enough to fall. Any influence then, Brownian motion, similar electric charge, or protecting films, may help keep the particles small and aid them in staying in suspension.

(*To be Continued.*)

FEDERAL COUNCIL FOR PURE AND APPLIED CHEMISTRY.*

For many months before his death, Lord Moulton was occupied with the elaboration of a scheme for ensuring the closer co-operation of the various interests—academic and technical, pure and applied—which are embraced by our numerous chemical organisations. Lord Moulton was convinced that a serious defect in the organisation of public affairs in our country lies in the lack of solidarity of sentiment and of expression amongst chemists as a body. The culminating task of his life consisted in unifying the scattered chemical talent of the country, and teaching it to work for the common cause in unison with the engineer and the manufacturer; as Director of the Department of Explosives Supplies, he accomplished this task, but none realised better than he that the extravagant cost of the achievement was largely traceable to the absence of previous organisation among chemists. His insight, born of genius and sharpened by experience, told Lord Moulton that the conditions of peace are much like those of war: co-operation saves labour and treasure, and leads to that efficiency which is essential in a modern economic struggle. He saw the necessity of creating for chemistry a corporate organisation in which all branches of the science and practice should be embraced, which could put forward its collective view with the same force as had long been possible in other learned professions, such as engineering, medicine, and the law.

With this outlook, Lord Moulton threw himself whole-heartedly into the scheme of the Federal Council for Pure and Applied Chemistry, and drafted an appeal for funds in order to rid British Chemistry of certain obvious disadvantages under which it now suffers. He believed that what is needed in this country is a central organisation for chemistry, which should bring under one roof our several important chemical societies, an exhaustive library, ample rooms for administrative purposes and for scientific meetings, and, if possible, the social amenities of a club. There was no thought of injuring the splendid traditions of the Chemical Society and the Society of Chemical Industry; both should retain their autonomy, but if these and other smaller allied societies are to meet modern requirements, there must be that closer co-operation which only comes from physical proximity.

The provision of the needs just above mentioned calls for funds, and in the appeal which Lord Moulton drew up at the end of 1920 he estimated that £250,000 was required for premises, equipment, etc., and a further £250,000 for literary purposes. This appeal was agreed by the Federal Council, and was signed by the Presidents of the sixteen societies then embraced by the Federal Council; it was being placed before prominent personalities in the chemical and manufacturing world for several months previous to the sudden death of Lord Moulton in March of last year.

We have lost our leader; we realise that we cannot hope, in the present condition of the world's financial affairs, to raise £250,000 for our project of placing chemistry in a position similar to that now enjoyed by engineering, medicine, and the law. Pending the better times which we all believe are in store for British industry and British enterprise, we can, however, do much to advance our project. We already have in existence a unifying body. The Federal Council for Chemistry was founded several years ago, with a view to meeting

* *From the Journal of the Society of Chemical Industry, December 15, 1922.*

two generally recognised needs: first, the promotion of co-operation and economy of effort between our several large chemical societies, and, secondly, the representation of those interests of chemical science and technology which are too general in character to be the sole province of either of our existing organisations. Following the example set by the creation of our own Federal Council for Chemistry, many other countries have formed a national Council for Chemistry on very similar lines; all these national councils are now combined under the International Council for Chemistry which was inaugurated at the annual meeting of the Society of Chemical Industry in 1919 (J., 1919, 38, 208T). The International Council now includes the national chemical councils of twenty-four States (J., 1922, 41, 328R); it has held its three previous annual meetings in Brussels, Rome, and Lyons, and is to meet next year in Cambridge.

Hitherto, the International Union for Chemistry has been largely occupied with the organisation of its numerous international interests, such, for instance, as concern the production of international tables of fundamental constants of the elements and the introduction of a generally agreed system of chemical nomenclature; the "Tables annuelles de constantes et données numériques de chimie, de physique et de technologie," edited with such success by Dr. Charles Marie, are published under its auspices. Now that these and related matters of importance have been dealt with, and organisations created which will rapidly increase its productivity, it is intended to extend the scope of the Union and to include in its annual proceedings the presentation and discussion of reports on the progress and development of large scientific and technical questions. This branch of the Union's activities was indeed inaugurated at the recent meeting at Lyons, and the meeting at Cambridge next year will therefore be one of great interest and importance.

Our own Federal Council has taken an active part in the pioneer work of the International Union, although it should be stated that the bulk of the progress made has been due to the devotion of Professor Charles Moureu, its President for the last three years, and our other French colleagues. The Federal Council, in addition, has been able to do a good deal in securing joint action between our large organisations, such, for example, as promoting the arrangement for some measure of co-operation between the Chemical Society and the Society of Chemical Industry in the weekly publication of the *Journal* of the latter Society. A vast amount remains to be done in this direction, and especially in the establishment of a solid feeling that the chemist should have at heart the interests of his whole subject rather than that merely of the particular chemical society of which he is a member. The promotion of this feeling calls for the united effort of all chemists. It was with this purpose in view that the societies composing the Federal Council were asked to nominate to the Council men who would be active in initiating and carrying into operation measures for the strengthening of the whole chemical organisation of the country.

Hitherto, the principal expenses of the Federal Council have been the annual subscriptions to the International Union, and the revenue has consisted mainly of grants from the Chemical Society and the Society of Chemical Industry. These grants cannot be increased, because both societies have already large calls upon their limited resources for other indispensable purposes; yet money is required to enable the Federal Council to develop its work on an adequate scale. At the meetings of the International Council in Brussels, Rome, and Lyons, the foreign organisations corresponding to our Federal Council entertained the delegates to the Union. We shall have to return the compliment at next year's meeting in Cambridge. Further, whilst the prevailing financial stringency makes it impossible to carry out the large scheme outlined by the late Lord Moulton, it is at least necessary that we should make a beginning. We therefore ask for contributions to be devoted towards the scheme, and so convert into a useful form the sympathy of our chemical colleagues with the objects of the Federal Council.

In the present article we have touched on many questions—and therefore, perhaps, in too scanty detail—and have left unmentioned many others which are also of vital importance to the chemical organism. The nudity of our chemical compendia, the paucity of our efforts to cultivate the social side of chemistry, and so develop the excellent work of the Chemical Industry Club—these and many other matters call for attention; they call for a few chemists to

lead and for many to collaborate, and above all they call for financial support.

With the above considerations in view the Federal Council has appointed a Benefaction Committee, with the request that they will collect funds. The Committee now consists of Sir William Pope, Dr. E. F. Armstrong, Mr. H. E. Coley, Mr. E. V. Evans, Mr. Emile Mond, Mr. W. J. U. Woolcock, and Dr. S. Miall; other names may be added at a later date. It is intended to issue a preliminary list of subscriptions, and when this has been completed to make a widespread appeal in a more or less public manner. It is requested that contributions be sent to Dr. S. Miall, Society of Chemical Industry, Central House, Finsbury Square, London, E.C.

W. J. POPE.
E. F. ARMSTRONG.
H. E. COLEY.
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EMILE MOND.
W. J. U. WOOLCOCK.
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PROCEEDINGS OF SOCIETIES.

THE CHEMICAL SOCIETY.

ORDINARY SCIENTIFIC MEETING, THURSDAY, DECEMBER 21ST, AT 8 P.M.

The following paper was read:—

Benzbisthiazoles, Part II., S. R. H. EDGE.

THE PHYSICAL SOCIETY AND OPTICAL SOCIETY'S ANNUAL EXHIBITION.

This exhibition, which is to be held on Wednesday and Thursday, January 3rd and 4th, 1923, at the Imperial College of Science, South Kensington, will be open in the afternoon (from 3 to 5 p.m.), and in the evening (from 7 to 10 p.m.).

Mr. W. Gamble will give a lecture on "Reproduction of Colour by Photographic Processes," at 4 p.m. on January 3rd, and at 8 p.m. on January 4th. Professor E. C. Coker, F.R.S., will give a lecture on "Recent Photo-Elastic Researches on Engineering Problems," at 8 p.m., on January 3rd, and at 4 p.m. on January 4th. All the lectures will be illustrated by experiments. Over 50 firms are exhibiting scientific apparatus, and a number of experimental demonstrations have been arranged.

We understand that invitations have been given to the Institution of Electrical Engineers, the Institution of Mechanical Engineers, the Chemical Society, the Faraday Society, the Wireless Society of London, and the Rontgen Society. Admission in all cases will be by ticket only, and therefore members of the Societies just mentioned desiring to attend the exhibition should apply to the Secretary of the Society to which they belong. Others interested should apply direct to F. E. Smith, O.B.E., F.R.S. Hon. Secretary of the Physical Society, Admiralty Research Laboratory, Teddington, Middlesex.

ROYAL MICROSCOPICAL SOCIETY.

20, HANOVER SQUARE, LONDON, W.1.

A meeting of the Society was held in the Lecture Hall at the above address on Wednesday, 20th December, 1922, at 7.30 for 8

p.m., when the following papers were read:

MR. JOSEPH E. BARNARD, F.INST.P., F.R.M.S., *Sub-Bacteria*.

MR. HUMPHRY J. DENHAM, M.A. (OXON.), F.R.M.S., *A Micrometric Slide Rule*.

MR. J. R. NORMAN, F.R.M.S., *Methods and Technique of Reconstruction*.

GEOLOGICAL SOCIETY OF LONDON

The following communications were read:

1. *Geological Investigations in the Falkland Islands*, by HERBERT ARTHUR BAKER, D.Sc., D.I.C., F.G.S.

2. *On a Collection of Fossil Plants from the Falkland Islands*, by ALBERT CHARLES SEWARD, Sc.D., F.R.S., PRES.G.S., and JOHN WALTON, B.A.

GENERAL NOTES.

TRADE FACILITIES AND LOAN GUARANTEE BILL.

The chief purpose of this Bill, which has passed through the House of Commons, is to amend the Trade Facilities Act, 1921, and to extend its scope. The Bill increases from £25,000,000 to £50,000,000 the total amount of loans the principal and interest of which may be guaranteed by the Treasury, and extends the period during which guarantees may be given till 9th November, 1923. Under the original Act the power to give guarantees expired on 9th November last. Guarantees of loans to the amount of £22,243,645 have been given, so that under the new Bill, which permits a total amount of fifty millions, powers will be given to guarantee £27,756,355 of loans in addition to those already made.

Powers are taken in the Bill to charge fees to applicants for guarantees so as to cover the cost of administration.

THE ROCKS OF MOUNT EVEREST.*

The efforts of the members of the Mount Everest expedition of 1922 to reach the summit of the mountain have already been fully given in the public press. That it was found possible to reach an altitude of 27,300 feet, with the aid of oxygen, is sufficiently noteworthy. It is still more interesting that a third expedition is already being tentatively considered, and a greater degree of optimism is felt by the climbers as to ultimate success than after the effort of 1921; this is based practically on the fact that the physiological effects at altitudes of 26,000 and above were found to be less serious than anticipated.

Dr. A. M. Herron has given the results of the examination of rock specimens collected at heights from 23,000 to 27,000 feet. The conclusion is reached that "Mount Everest is a pile of altered sedimentary rocks—shales and limestones—converted into banded hornfels, finely foliated calc-silicate schists, and crystalline limestones. The hornfels and fine schists are in the field blackish or dark green rocks, conspicuously slabby and with a general low dip to the north, which, I believe, adversedly and even dangerously affected climbing. The crystalline limestones are fine-grained pure white rocks. The specimens from 23,000 to 25,000 feet show in microscope sections a very fine-grained aggregate of quartz and a greenish mica, with irregular lenticles and veins of chlorite and epidote, and in addition sometimes calcite pyrites and sphene.

"The mountain, from 21,000 to 27,000 feet, is made up of these black and dark green rocks, with occasional beds of white limestone, and veins of quartz and muscovite granite. From 27,000 to 27,500 feet extends an almost horizontal belt, a sill in fact, of schorl muscovite granite, along the whole length of the mountain, which rock presumably, by its superior hardness, gives rise to the prominent shoulder of the mountain north-east of the main peak (shown as 27,390 on Major Wheeler's photographic survey map). Above this again are black schists. Captain Finch informs me that he saw ammonites at a height of about 26,500 feet, but was unable to collect them.

"As to the age of the rocks forming Mount Everest, they may perhaps be assumed, for the present, to be Jurassic or Trias." *London Geological Journal*, September, 1922, pp. 219, 220; see also July,

pp. 67-71, August, pp. 141-144, and October, pp. 288-291, with fifteen beautiful reproductions from photographs.

* *From The American Journal of Science, November*, 1922.

A NEWLY FOUND TENNESSEE METEORIC IRON.*

By G. P. Merrill (Communicated).

State Geologist William A. Nelson has forwarded to the U.S. National Museum a mass of meteoric iron recently found by Messrs. C. D. McKnight and M. W. Spencer while working on the roadway leading from Savannah to Cerro Gordo, some four miles north-east of the first-named town in Hardin County, Tennessee. The mass is 18 inches in length, roughly dumb-bell shaped, and weighs 132 lbs. It is an octahedrite in crystallisation and much weathered, undoubtedly representing an old fall. A cast will be made of it, after which it will be cut and analysed, a portion being retained at the National Museum, and a portion returned for the State collection at Nashville.

* *From the American Journal of Science, November*, 1922.

MINOR FAULTING IN THE CAYUGA LAKE REGION.*

By E. T. Long.

The following corrections should be made in the above article in the number for April (pp. 229-248):—

The first line on p. 232 should read: *The Watkins Glen-Catatonk folio deals with*, etc.

Page 233, line 26 from top, *Enclinal* should read *Encrinal*.

Page 236, line 4 from top, *north* should read *south*.

Page 247, line 18 from top, *Cayuga* should read *Cayuta*.

Page 247, line 23 from top, *Cayuta* should read *Cayuga*.

* *From the American Journal of Science, November*, 1922.

NOTICES OF BOOKS.

The British Journal Photographic Almanac and Photographers' Daily Companion. 1923. Edited by George E. Brown, F.I.C. Pp. 808. London: Henry Greenwood & Co., Ltd., 24, Wellington Street, Strand. Price, paper covers 2s., cloth bound 3s. net.

It is pleasing to note that this issue of the *Photographic Almanac* shows signs of an approach to the pre-war issues. The paper upon which it is printed is better than that used for the last few issues.

Naturally, the Almanac has been compiled primarily for the use of photographers. For these it contains most valuable information and data, including specific details concerning all the photographic processes.

Perhaps the most important section, and the one which will be of greatest interest to the scientific public, is the Epitome of Progress, ably compiled by the Editor himself. It includes a bibliography and full accounts of new apparatus and equipment, methods of photographing various subjects, negative and printing processes, and colour photography. Readers desiring fuller details are referred to the original articles or British abstracts, which are also quoted.

Its utility as a reference volume is enhanced by the inclusion of tables of physical and chemical constants, and also a directory of the photographic trade.

In the preface, the Editor invites suggestions, and it is to be hoped these will be received during the next six months, since later in the year it may be too late to consider new features.

Altogether, the *B.J. Photographic Almanac* maintains its high reputation in the 1923 issue, which will be invaluable to photographers, and particularly to those who have a knowledge of chemistry.

J.G.F.D.

The Origin of Spectra, by Paul D. Foote and F. L. Mohler. Pp. 250. New York: The Chemical Catalog Co. Inc., 19, East 24th Street. 1922. Price $4.50.

The experimental aspect of the study of Spectra has hitherto received comparatively little attention, except at the hands of a number of physicists, who have published their results in the various scientific journals.

The subject is recognisedly in a transitional stage, and the theoretical interpre-

tation of the phenomena given by these authors is not intended to be taken as final.

A century ago study and speculation concerning atoms and molecules was conducted by chemists, but a time has come when further knowledge and theoretical deductions in this subject have been obtained by physicists.

This may be due to the regrettable fact that chemists generally do not extend, or sometimes even retain, the mathematical knowledge acquired in collegiate days.

Such will find the reading of this work very difficult.

The authors have compiled their volume from the original papers and the spectral lines and tables obtained by various investigators, amongst whom they themselves can claim to have done a great deal in this subject.

The American Chemical Society is to be congratulated upon publishing such a volume, the utility of which will be very considerable for those investigators interested in this important new subject, but it is to be feared that the main body of chemists will not be able to derive the greatest value from this excellent monograph on account of the limitation alluded to above.

The Theory of Emulsions and Emulsification, by William Clayton, D.Sc., F.I.C., with a Foreword by Prof. F. G. Donnan, M.A., Ph.D., D.Sc., F.R.S. Pp. VIII. + 160. London: J. & A. Churchill, 7, Great Marlborough St., W. 1923. Price 9s. 6d.

Whilst there are several well-known volumes which have chronicled the progress in the study of Colloids, none have so far specifically dealt with Emulsions and Emulsification.

The theoretical and industrial importance of emulsions is certainly sufficient to justify the publication of this monograph.

A study of the subject has thrown light upon the problems of surface tension, adsorption, and the Brownian movement, as well as aiding in the elucidation of other problems connected with Colloid Chemistry.

The industrial importance of emulsification will be more fully realised when it is recalled, as Prof. Donnan does in his foreword, that such substances as milk, butter and margarine are emulsions. Various problems connected with lubrication and with the preparation and properties of detergents may be simplified by a more extensive knowledge of the principles of emulsification.

The author has dealt with the subject from the standpoint of physical chemistry, and the treatment has been very thorough, but in the table on p. 20, gum mastic is left in its original German, Mastixharz, as it appeared in the Zeitschr. phys. Chem., 1912.

This subject, and hence this volume, is of considerable importance, not only to physicists and chemists, but also to many engineers, pharmacists, agriculturists, and others.

New Patents.

This list is specially compiled for the *Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs, can be obtained gratuitously.

Latest Patent Applications.

32954—Carroll, J. C.—Extraction of titanium from ilmenite, etc. Dec. 2.

32520—Hirschberg, L. M.—Compositions containing formaldehyde. Nov. 28

32647—Layraud, E.—Manufacture of asymmetrical dialklbarbituric acids and products therefrom. Nov. 29.

32897—Moore, Q.—Recovery of ammonia. Dec. 1.

Abstract Published this Week.

Ammonium Sulphate.—Patent No. 187035.—*Some improvements in the manufacture of Ammonium* Sulphate have recently been devised by Messrs. Holmes & Co., Ltd. W. C., Whitestone Iron Works, Huddersfield; Adams, W. G., Tar and Ammonia Product Works, Beckton; and Cooper, C., Whitestone Iron Works, Huddersfield.

Ammonium sulphate is dried and neutralized in one operation by mechanically conveying the crude salt through a chamber of casing through which flows a current of ammonia gas and heated air in the reverse direction to the salt. The crude salt is fed into a chamber of rectangular cross-section through an opening, and is conveyed by a twin spiral conveyers to the discharge aperture. A casing of thin sheet metal partly surrounds the upper portion of the chamber, and is heated by a gas-burner controlled by a valve. Air is drawn into the chamber through apertures in the casing through which the burner-gases may also pass. Ammonia gas is introduced through the inlet and passes out, together with the heated air, through an aperture, this aperture being connected to a suction device and to apparatus of known type in which the excess ammonia and pyridine, if present, are separated from the residual gases by treatment with acid. Alternatively, the heated air and ammonia may be formed into the chamber under pressure, and the directions of the gas-current and crude salt may be reversed, in which case the chamber is made in the form of a rotary cylinder.

Messrs. Rayner & Co. will obtain printed copies of the published Specifications, and forward on post free for the official price of 1s. each.

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